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A PLETHYSMOGRAPHIC STUDY OF ATTENTION.[1]

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[1] From the Psychological Laboratory of Cornell University.

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A. Introduction.

1. *Reasons for the failure of the method of expression as applied to the study of the feelings.*

If the success of a scientific method is to be tested by the consensus of result which follows its application, the method of expression as applied to the study of the feelings must be pronounced a failure.[1] The failure is the more surprising, since the method seemed well adapted to its purpose. The organic concomitants of emotive phenomena are so patent, that they in themselves seemed to assure the effectiveness of the method; and, furthermore, in the case of the simpler affective processes, evolutionary theory seemed to indicate a logical ground. Although the conception of the method is supported by common observation and by theory, a long series of investigations has ended in contradictory or negative results. This failure of the method of expression cannot be attributed to the instruments at its disposal, because they are as perfect as the present state of physiology permits. Nor is it likely that the experimenters have been at fault. The causes must be sought elsewhere. Two possible causes suggest themselves: (i) the complication of affective processes by other mental processes; (ii) the purely physiological processes set up by the stimulus itself. If the method is to be made serviceable for the study of affective processes, the results of these two factors must be known and must be taken account of.

[1] See Appendix, for proof of this statement.

Already something has been done towards the study of these two factors. Mosso, Gley, Féré, and Delabarre have all studied the effects of intellectual activity as something different from the effects of the feelings or emotions. So, also, have Binet and Angell. McDougall has made a special study of the physiological characteristics of states of attention. Lehmann devotes, in his later work, a chapter each to the feelings and to attention and their relations. Recently, Zoneff and Meumann have approached more closely the relation of attention to affection. But with the exception of the last two references the aim of this work has been to apply the method of expression to another mental phenomenon, and not to see how far the expression of affective processes is being masked by the expression of other mental processes. The second factor has been greatly neglected. Mentz, in 1895, made a long study of the effects of auditory stimuli on pulse and respiration, with the result that auditory excitations cause a slowing of pulse and respiration, independently of any mental process. So also, in his second work, did Lehmann determine the purely physiological effects of certain stimuli. Very lately, Kelchner has raised the question how much of the effect of the method of expression is due to the stimulus and how much to the mental process. The aim of the present study is to add something to the knowledge of these two factors, with a view to forcing either the rehabilitation of the method of expression or its final abandonment. It should be understood that we did not attempt a psychological analysis of attention. Introspection was incidental rather than essential to our method. Our interest was chiefly psychophysical. We wished to know what physiological concomitants those states have, which without too much refinement of definition may be fairly characterized as states of active attention. The experimental material was obtained from a detailed study of attention under a great variety of conditions, by means of the expressive method.

2. *Apparatus and conditions of experimentation.* The instruments used in this work were Lehmann's plethysmograph and the Verdin pneumograph. The volume curve furnished the change in rate of pulse as well as the changes in volume. The measurement of the pulse rates from the plethysmogram seems to be warranted by the practice of Lehmann, and of Angell and McLennan. Both recorded the radial pulse on the one arm while the volume of the other arm was being recorded. But as no essential difference came out between the measurements of the two curves, the sphygmograph was not often used. The height of water in the manometer of the plethysmograph which was found to yield the optimal height of pulse was about 18 cm. The temperature of the water was

kept as near 37° Centigrade as was possible. The plethysmograph was always placed on the right arm. The left hand held the key of an electromagnetic signal. The pneumograph was applied to the lower thorax in the case of male observers, and to the upper thorax in the case of female observers. Both the pneumograph and the plethysmograph were connected with their respective Marey tambours by a thick walled rubber tube 1 meter long, with a lumen 4 mm. in diameter. The length of the writing lever for the pneumograph tambour was 230 mm. The distance from the fulcrum to the point at which the force was applied was 6 mm. The magnification of the curve was, therefore, 38 times. The corresponding dimensions for the lever of the plethysmograph tambour were 235 mm. and 8 mm. The magnification, therefore, was 29 times.

The records were taken on a clock-work kymograph made by C. H. Stoelting. The drum was 28 cm. long and 15 cm. in diameter. With the middle rate of revolution, the period of the drum was, approximately, 140 seconds. The mean variation of the kymograph was determined by measuring the number of seconds that fell within a 30 mm. space. The number of seconds varied about 9 as a norm. When the drum was first wound up and stopped after each revolution, the value fell slightly below 9. After 20 minutes of continuous running the value was slightly above 9. Under the former condition the mean variation was 0.12; under the latter, 0.08. The experiments were all made under the former condition. One electromagnetic signal was made to serve three purposes. It served to mark time in seconds from a Zimmerman clock; it served also as a signal for both experimenter and observer. In the two latter cases, a closure of the circuit prevented the making of seconds, so that a dash appeared in the time line. Since only 1 or 2 seconds were ordinarily obliterated, they could easily be interpolated when the reaction was measured. This arrangement saves space on the drum, and for the conditions of our experiments was without any essential error. Each record, therefore, consisted of three curves (counting from above downward), pneumogram, plethysmogram, and the combined time and signal line. The pneumograph tambour was inverted in order to close up the gap between the pneumogram and the plethysmogram. This fact must be taken into account in reading the pneumogram, since an up stroke of the stylus means an inspiration, while a down stroke means expiration.

With these instruments and conditions four physiological characters were determined in each curve; rate and depth of respiration, rate of pulse, and volume of the arm. Height of pulse was not attended to, as we did not consider the apparatus

reliable for that determination. The rates of respiration and pulse were measured by counting the number of respirations and pulses that fell within a 10 second interval. This interval was determined by erecting, at every 11th second, a vertical on the time line. The space, therefore, between two successive verticals represents 10 seconds. The changes in volume and depth of respiration were determined by inspection. A decrease in the height of the breathing curve is always spoken of as 'inhibited breathing.' Each record has 3 periods: the normal or indifferent period, the reaction period, and the period of recovery. It was attempted to make each period 40 seconds in length; but this was not feasible in some experiments. For short reaction periods, the rates were measured in 5 second intervals. In such cases, the results were multiplied by 2, so as to make the averages comparable with the averages of the normal and recovery periods, which were measured in 10 second intervals.

The following observers shared in the experiments: Drs. Bentley and Baird, Miss Jenkins and Miss Andrus, Messrs. Sabine and Galloway. Mr. Galloway began to observe with Exp. 57. Miss Andrus did not observe after Exp. 36. The normal curves of Dr. Baird, Miss Andrus, Miss Jenkins and Mr. Sabine were recorded for a period of several months prior to the experiments with reactions. The average rates of pulse and respiration, with the mean variation of each, are given in a table. The numbers which enter into these averages were obtained by measuring the number of pulses and respirations for each 10 seconds of each record. The average rate for each record is found by taking the average of the 10 second values. The final average for each observer is made by taking the average of all the records. The mean variation is the average deviation of the average of each record from the average of all the records. The number of records of both pulse and respiration is also given.

Observer	R	P	*MV* of R	*MV* of P	No. of R	No. of P
Sabine	3.06	12.8	0.138	1.21	42	39
Miss Andrus	2.58	14.6	0.199	1.31	34	33
Miss Jenkins	3.24	11.5	0.237	0.24	26	20
Baird	1.83	10.0	0.123	0.43	9	9

This table not only brings out marked individual differences in the normal rates of *P* and *R*, but the mean variations

show the degree of susceptibility to spontaneous variation of different observers. Experiments were made once or twice a week at the same time of day for each observer. These hours were 12-1, 3-4, and 4-5 P. M. The observers were comfortably seated, holding a signal key in the left hand. A curtain shut off the kymograph and experimenter from the view of the observer. Two or three records were made at each hour.

Some abbreviations and terms used in the description of the experiments require explantion. Each experiment is divided, as we have said, into three parts: normal, reaction, and recovery. An unequivocal change in the reaction value of pulse and respiration means a change which differs absolutely from the rates of both normal and recovery. For example: an unequivocal increase in the rate of pulse means an increase over both the normal and recovery rates. An equivocal change in the reaction rate is one that does not differ absolutely from both normal and recovery rates. For example, the reaction rate may be faster than normal, but slower than recovery; or slower than normal, and faster than recovery. It is a question of some importance to know how to treat these equivocal reactions. *R* stands for respiration; *P* for pulse; *V* for volume. The length of time of each period is given in seconds above the measurements for each period. The average rates of *R* and *P* are given below the measurements for each period. For example, in Exp. 1, the normal period was 85 seconds long; the reaction 35 seconds; the recovery 30 seconds. The figures standing opposite *R* and *P* are the number of respirations or pulses which occur in ten seconds. A blank in a series of figures means that the curve, for some reason, was not legible. 3.5, 3.7, 3.8, are the average rates of *R* for the three periods of the experiment. 13.7, 13.3, 12.8, are corresponding values for *P*. The changes in depth of breathing and volume are given in words. It will be seen that the reaction of both *P* and *R* in this experiment is equivocal. *O* stands for observer; *E* for experimenter.

B. Experiments on the State of Attention.

I. Attention to Visual Stimuli.

1. Stimulus: A Masson Disc. The disc was rotated on a hand color mixer. *O* attended to the fluctuations of one of the rings.

Exp. 1. Sabine.

				1″—85″				
R	3.00	4.00	3.50	4.75	3.25	3.75	3.00	3.00
P	——	12.5	15.0	14.0	14.0	14.5	13.0	13.0

3.5
13.7

1″—35″				1″—30″			
4.00	3.50	3.75	3.75	4.25	3.25	4.00	
14.0	13.5	13.0	13.0	13.5	13.0	12.0	
		3.5			3.8		
		13.3			12.8		

During reaction: *R* is somewhat inhibited; there is one deep inspiration.

V falls slowly to the end of reaction; then rises during recovery.

EXP. 2. SABINE.

	1″—49″					1″—32″				
R	3.50	3.50	3.50	3.25	3.75	3.50	4.00	3.75	3.50	3.50
P	12.0	12.0	12.5	12.5	12.5	12.0	13.0	12.5	12.0	12.5
			3.5					3.6		
			12.3					12.4		

1′—30′				
3.25	2.75	3.00	3.25	3.25
12.0	12.5	12.0	12.0	12.0
		3.1		
		12.1		

During reaction: 2 *R* are inhibited (just after signal); for 20″ depth is normal; then 4 hypernormal *R* followed by 3 inhibited *R*.

V falls slowly throughout reaction; reaches minimum at end of reaction; rises during recovery.

EXP. 3. SABINE.

	1′—39′				1′—42′				
R	3.50	3.50	3.00	3.50	3.75	3.75	3.75	4.00	3.75
P	——	11.5	13.0	12.0	13.5	14.0	14.0	13.0	12.5
		3.5					3.8		
		12.1					13.4		

1′—60′						
3.25	3.25	3.50	3.25	3.50	3.25	——
12.0	12.5	11.5	12.0	11.5	11.5	11.6
		3.3				
		11.8				

During reaction: 1 *R* is deeper than normal; inhibition sets in and reaches maximum at the middle of reaction. It gradually lessens to the end of reaction.

V falls slightly after first signal, rises, then falls steadily to near the end of reaction. It rises sharply and steadily during recovery.

EXP. 4. MISS JENKINS.

	1′—39′				1′—55′					
R	3.30	3.00	3.45	3.27	3.60	4.00	3.95	3.95	3.80	3.40
P	11.5	11.5	12.5	12.3	12.5	13.0	12.5	12.0	11.5	12.0
		3.27					3.78			
		11.9					12.2			

1″—38′			
4.05	3.40	3.05	3.37
12.0	11.5	11.5	11.8
	3.46		
	11.7		

During reaction: *R* is inhibited; inhibition seems to pass off toward the end of the reaction.

V does not fall immediately; falls suddenly and remains low for 15″; rises to end of reaction.

EXP. 5. MISS JENKINS.

1″— 62″

R	3.40	3.20	3.50	3.75	3.50	3.75	
P	12.0	——	12.5	12.5	12.0	11.2	

3.51
12.2

1″— 36″

3.75	4.00	4.00	3.75	
12.0	12.5	13.0	12.5	

3.87
12.5

1″— 35″

4.25	3.70	4.00	3.60	
13.5	11.5	13.0	12.0	

3.88
12.5

During reaction: *R* is slightly inhibited.

V is not very constant. After the beginning, it falls slightly; rises to a first maximum; falls slowly to the middle of the reaction; then rises to a second maximum at the end of the reaction.

EXP. 6. MISS JENKINS.

1″—35″

R	3.75	3.75	3.75	3.80	
P	13.0	12.0	12.5	12.0	

3.76
12.3

1″— 35″

4.05	3.95	4.00	4.00	
12.5	12.0	12.0	12.0	

4.00
12.1

1″— 56″

3.75	4.10	4.00	3.25	3.90	3.50	
13.0	13.0	12.5	11.5	12.5	10.7	

3.75
12.2

During reaction: *R* is slightly inhibited.

V rises 20″ after the beginning of the reaction and continues high until 10″ after reaction.

EXP. 7. MISS ANDRUS.

1″— 53″

R	3.10	3.30	2.25	2.75	3.45	2.50
P	——	12.0	12.0	12.0	13.0	13.3

2.90
12.0

1″— 35″

3.50	3.35	3.90	3.00	
13.2	13.0	13.5	14.0	

3.43
13.4

1″— 38″

3.75	3.00	3.00	3.00	
13.0	12.75	12.0	11.25	

3.18
12.2

During reaction: *R* is inhibited at first. There are then 2 hypernormal *R*; 2 normal *R*; and 2 inhibited.

V does not change. The plethysmograph functioned as a sphygmograph.

EXP. 8. MISS ANDRUS.

	I″— 40″				I″— 36.5″			
R	2.80	2.50	2.70	3.10	2.95	2.95	3.00	3.08
P	10.5	10.0	11.0	11.0	11.5	11.5	11.0	12.3
	2.83				2.99			
	10.6				11.5			

I″— 59.5″

R	1.75	1.80	2.25	2.00	2.75	2.87
P	11.0	11.0	11.0	11.0	11.0	11.1

2.23
11.0

During reaction: the height of *R* is increased.
V is diminished.

EXP. 9. BAIRD.

	I″— 40″				I″— 39″			
R	2.25	1.90	1.85	1.75	2.25	2.25	2.35	2.50
	1.92				2.43			

I″— 50″

2.75	2.25	2.50	2.05	2.20	

2.35

During reaction: *R* is greatly inhibited. *V* is diminished. (*P* is not legible.)

EXP. 10. SABINE.

	I″—48″					I″—32.5″			
R	3.00	2.75	2.90	3.45	3.43	3.60	3.65	3.55	3.33
P	——	13.5	13.5	13.0	13.7	14.0	14.0	14.0	15.0
		3.14				3.53			
		13.4				14.2			

I″—51.5″

3.50	3.25	3.20	3.00	3.00	3.00
13.7	13.5	14.0	13.5	12.5	13.0

3.31
13.3

During reaction: *R* is inhibited after the first and the second signals.
V falls to a low level in the middle of the reaction and rises to the end of reaction.

EXP. 11. SABINE.

	I″—34″				I″—32.5″			
R	3.25	3.15	3.01	3.65	3.35	3.55	3.40	3.60
P	14.0	13.2	13.5	14.4	13.2	12.7	13.5	16.0
	3.27				3.47			
	13.7				13.8			

I″—77.5″

3.75	3.20	3.50	3.15	3.30	3.00	3.07	
13.5	13.7	14.0	14.0	13.0	13.0	13.0	

3.28
13.4

During reaction: *R* is inhibited more during the first half of reaction than the last.
V is diminished during the reaction.

EXP. 12. BAIRD.

1″—42″

R	2.6	2.6	2.4	2.6	2.5
P	10.5	10.5	10.2	10.5	10.0

2.54
10.3

1″—48″

2.6	2.2	2.6	2.4	2.5	
10.2	10.7	10.5	10.5	10.0	

2.47
10.4

1″—40″

2.6	2.4	2.4	2.5	
10.0	10.0	10.0	10.0	

2.47
10.0

During reaction: *R* is inhibited.
V falls during reaction. It begins to rise 10″ after reaction.

EXP. 13. BAIRD.

1″—40″

R	2.4	2.6	2.4	2.5
P	10.2	10.2	10.2	10.0

2.47
10.8

1″—40″

2.6	2.5	2.5	2.5	
10.5	10.0	10.0	10.0	

2.54
10.1

1″—60″

2.5	2.4	2.5	2.2	2.4
10.0	10.0	10.0	10.2	10.2

2.42
10.1

During reaction: *R* is inhibited.
V is diminished.
The respiratory oscillation which was very marked during normal and recovery was suppressed during reaction.

EXP. 14. BAIRD.

1″—40″

R	2.5	2.2	2.6	2.6	
P	10.2	9.7	10.0	10.0	

2.48
10.0

1″—46″

2.6	2.7	2.5	2.4	2.3	
10.0	9.2	9.5	10.2	10.4	

2.51
9.8

1″—47″

2.7	2.4	2.7	2.4	2.5	
10.5	10.0	10.0	10.0	10.0	

2.56
10.1

During reaction: *R* is inhibited, more in the middle than at the beginning.
V falls somewhat after first signal; but rises before the end of the reaction.
The respiratory oscillation is suppressed.

Summary of Results.

Attention to *Masson disc* is characterized by

i. Unequivocally increased rate of *R* (10 cases out of 14). In 3 cases *R* is greater than normal and less than recovery; in 1 case less than normal and the same as recovery.

ii. Unequivocally increased rate of *P* (8 cases out of 14). In 1 case less than recovery and greater than normal. In 2 cases less than normal and greater than recovery. In 2 cases unequivocally slowed. In 1 case no experiment.

iii. Inhibited breathing. (In part in every experiment.)

iv. A fall in volume of the forearm. (In all cases except Exp. 6, in which *V* rises.)

2. Stimulus: Black Paper and After-Image.

Attention was directed to an oblong piece of velvet-black paper, 4 x 3.5 cm., exposed on a gray background. *O* fixated the paper for 15-20 seconds; then watched the development of the after-image on the screen. Both fixation and after-image phases are included in the attention period. The measurements of the fixation and after-image phases are separated within the total reaction, by a line of vertical dots. The average rates of *P* and *R* for each phase are to be found at the two ends of the reaction period. The average rates of *P* and *R* for the reaction considered as a whole are given between the averages for the fixation and after-image phases. For example, in Exp. 15, the average rate of *R* and *P* for the fixation phase of the reaction is 4.00 and 11.8 respectively; for the after-image phase, the rate of *R* and *P* is 3.63 and 11.8 respectively; for the reaction as a whole, the values are 3.87 and 11.8. In any general discussion of the results of these experiments only the last values are considered.

EXP. 15. MISS JENKINS.

	1″— 69″							1″— 20″		1″— 11″
R	3.30	3.60	3.40	3.00	3.90	3.80	3.60	4.25	3.75 :	3.63
P	12.0	12.6	12.0	12.0	12.0	11.7	12.2	12.0	11.7 :	11.8
			3.52					4.00	3.87	3.63
			12.0					11.8	11.8	11.8

1″— 37″

3.95	3.60	3.60	4.00
12.0	12.0	12.0	11.4

3.78
11.8

During reaction: *R* is inhibited during fixation; but not during after image.

***V* falls after the first signal at the beginning of the reaction, and rises again to normal level. It falls at the end of the reaction.**

EXP. 16. MISS JENKINS.

1″— 65″

R	——	——	3.75	3.50	3.90	4.00	4.00
P	——	——	12.0	11.75	12.0	12.0	12.5

3.83
12.0

1″— 20″			1″— 20″		1″— 29″		
3·90	4·00	:	3·2	4·2	3·75	3·90	3·66
12.0	12.75	:	12.0	12.0	12.0	12.0	11.6
	3·95		3·86	3·70		3·77	
	12.0		12.1	12.0		11.8	

During reaction: *R* is inhibited during fixation; there is a short period of deeper breathing between fixation period and after-image; the breathing is inhibited during after-image. *V* falls at the beginning and the end of the reaction with normal level between. During the normal period, there was a decided fall in *V* about 15 seconds before reaction; *V* returned to the normal level before the reaction. *O* reported that she looked at the screen and expected *E* to move it.

EXP. 17. MISS JENKINS.

1″— 58″

R	3.50	3.80	3.00	3.60	3.80	3.75
P	11.0	12.0	11.5	12.0	11.0	11.0

3.57
11.4

1″— 22″			1″—21″		1″— 34″			
3.60	3.75	3.40 :	3.80	3.60	3.90	3.75	3.75	3.75
11.5	11.5	12.0 :	11.5	10.8	11.5	11.5	11.5	11.5
3.58	3.63	3.70			3.78			
11.6	11.4	11.1			11.4			

During reaction: height of *R* is not much changed. *V* falls after each signal (at the beginning and the end of the reaction), with normal level between. During the normal, there was a noise made by a falling body. This disturbance may account for the increase in rate of *P* in the middle of the normal.

EXP. 18. BAIRD.

	1″— 40″				1″— 33″			1″— 21″		
R	2.50	2.30	2.20	2.00	2.50	2.30	2.25 :	2.55	2.45	2.40
P	10.0	10.5	10.75	10.25	10.2	10.5	10.75 :	10.25	10.5	11.0
		2.25				2.35	2.40	2.46		
		10.3				10.4	10.5	10.5		

1″— 40″

2.00	1.50	2.00	1.80
10.25	10.25	10.0	10.0

1.82
10.1

During reaction: *R* is inhibited strongly during fixation; somewhat less during after-image.

V remains nearly level throughout; there are marked respiratory oscillations during normal and recovery; these are suppressed almost entirely during fixation. They are not so much suppressed during after-image.

EXP. 19. BAIRD.

1″—39″

R	2.55	2.40	2.50	2.80
P	10.5	11.0	10.75	11.0

2.56
10.8

1″—37″				1″—27″				1″—30″			
2.25	2.40	2.30	2.60 :	2.50	2.30	2.30	2.00	2.00	1.90	1.90	
10.6	10.5	10.0	10.5 :	9.0	11.0	10.5	10.0	11.0	10.5	10.00	
	2.38		2.31			2.27			1.93		
	10.4		10.5			10.1			10.1		

During reaction: *R* is inhibited strongly during fixation; somewhat less during after-image. There are no changes in *V*, as the plethysmograph functioned as a sphygmograph.

EXP. 20. BAIRD.

	1″—40″				1″—42″					1″—19″	
R	2.50	2.40	2.10	2.60	2.25	2.25	2.90	2.50	2.60 :	2.30	2.50
P	11.0	11.0	11.5	11.75	11.25	10.0	10.75	10.5	10.75 :	10.25	10.0
		2.43				2.50		2.47		2.40	
		11.3				10.6		10.5		10.1	

1″—34″

2.0	1.9	1.6	1.5
10.5	10.25	9.5	10.0

1.75
10.0

During reaction: *R* is inhibited strongly during fixation; less strongly (but still inhibited) during after-image. *V* rises during fixation; falls before the end of fixation; rises during after-image.

EXP. 21. SABINE.

1″—40″

R	3·4	2·75	3·4	3·5
P	14·5	15·75	15·5	14·75

3·25
15·1

1″—40″				1″—30″			1″—30″		
3·30	3·40	3·45	3·25 :	3·45	2·60	3·10	2·9	3·00	3·25
14·5	14·25	15·0	15·25 :	13·25	14·0	14·0	15·0	15·5	14·75
	3·36		3·20		3·05			3·05	
	14·5		14·1		13·7			15·0	

During reaction: height of *R* is irregular; there is no change during fixation; but there is considerable inhibition during first half of after-image, although less during latter part. *V* falls during first part of fixation, rising to normal during latter part of fixation. It falls during the after-image and remains low throughout the rest of the reaction. It rises during recovery. *O* reports the most vivid after-image he ever saw. He was surprised and pleased.

EXP. 22. SABINE.

	1″—40″				1″—34″			1″—22″		
R	1.60	2.45	2.10	3.00	3.10	3.50	2.60 :	3.40	3.40	3.10
P	17.0	15.5	14.5	14.5	14.2	15.0	16.5 :	14.0	14.2	13.7
		2.28				3.00		3.10		3.20
		15.3				15.2		14.5		13.9

1″—40″

3·30	2.25	3·00	3·00
14·7	15·5	14·5	14·5

2.80
14.8

During reaction: *R* is inhibited as compared with the height of *R* in recovery. On the whole, there is a fall in *V*.

EXP. 23. SABINE.

1″—53″

R	2.50	3.00	3.00	3.00	3.10	2.60
P	15.0	14.25	13.2	14.2	14.5	12.5

2.80
13.8

1″—30″			1″— 22″			1″— 30″		
2.65	2.90	3.10	3.00	3.00	3.75	3.25	3.20	3.30
——	15.25	14.75	13.5	13.75	13.0	14.75	15.25	14.0
	2.80		3.02		3.25		3.25	
	14.8		14.1		13.4		14.6	

During reaction: *R* is markedly inhibited during after-image; but not during fixation. *V* falls after the initial and the final signals of the reaction.

EXP. 24. MISS ANDRUS.

1″— 42.5″

R	3.00	3.30	3.20	3.20
P	13.8	15.1	15.1	14.2

3.17
14.5

1″— 29.5″			1″— 50″					
2.94	3.05	3.33	3.45	3.45	3.25	3.25	3.20	No
14.2	15.0	15.5	15.0	14.7	15.0	14.6	15.1	recovery
	3.10		3.21		3.32			
	14.9		14.8		14.8			

During reaction: *R* is not changed during fixation, but it is deeper and more regular during after-image. *V* falls at the beginning and end of fixation; it is normal between. There is a gradual fall in *V* during the after-image.

EXP. 25. MISS ANDRUS.

1″— 46″

R	3.10	2.90	2.75	3.00	3.20
P	15.0	15.0	14.4	14.8	14.6

2.99
14.7

1″— 17″			1″— 29.5″			1″— 33″		
3.05	2.85	2.95	3.05	3.10		3.33	2.75	3.10
14.4	13.8	13.7	14.3	14.4		13.3	13.5	13.8
	2.95		3.03				3.06	
	14.1		14.1				13.5	

During reaction: *R* is inhibited during fixation and the first part of after-image. *V* is subnormal, with marked depressions after the beginning and the end of the reaction.

EXP. 26. MISS ANDRUS.

1″— 44″

R	3.40	2.80	2.90	3.35
P	14.0	13.6	14.0	15.0

3.11
14.1

1″— 14″		1″— 25″		
3.23	3.25	3.20	3.00	
13.5	13.8	14.6	13.2	
	3.23	3.19	3.15	
	13.5	13.7	13.9	

1″—45″

3.00	2.90	3.05	3.45	2.10
13.7	12.8	13.0	13.6	12.0

2.90
13.0

During reaction: on the whole, there is a fall in *V*, with sudden dips at the beginning and the end of the reaction. *R* is inhibited during fixation, although it is normal for after-image.

Summary of Results.

Attention to stimulus and after-image is characterized by

i. Unequivocally increased rate of *R* (8 out of 12 cases).

In 2 cases *R* is less than normal, but greater than recovery.

In 1 case *R* is same as normal, but less than recovery.

In 1 case *R* is greater than normal, and less than recovery.

For the unequivocal increases in rate of *R*, the fixation rate is greater in four cases and the after-image greater in four cases. In the two cases where reaction is less than normal but greater than recovery, *R* during fixation is faster than during after-image. In the two cases where reaction is the same or greater than normal but less than recovery, the rate of *R* for after-image is greater. In six cases each, is the respiration rate faster, during fixation and after-image.

ii. Unequivocal increase in the rate of *P* (3 out of 12 cases).

In 5 cases *P* is greater than recovery, but less than normal.

In 1 case *P* is greater than normal, but less than recovery.

In 2 cases *P* is unequivocally less than either normal or recovery.

In 1 case *P* is greater than normal; but there is no recovery in that experiment.

For the unequivocal increase in rate of *P*, fixation rate is faster in two cases. For the cases where *P* is greater than recovery but less than normal, the fixation rate is faster in three cases, the same in one case, slower than the after-image rate in one case. For the one case of reaction *P* less than recovery but more than normal, fixation rate is greater. For the two cases of unequivocal slowing, fixation is faster. For the case where there is no recovery, fixation is faster. In all, fixation *P* is faster than after-image *P* in 9 cases, slower in two cases, same in one case.

iii. Inhibited breathing in nearly every case; more in fixation than in after-image.

iv. Lower level of *V* of arm. In one case (exp. 20) there is a rise in *V* during fixation. In most experiments, there is a sudden fall in *V* at the beginning and end of reaction with normal level between.

3. Stimulus: Closely drawn radii of circle. *O* was asked

to count the number of radii. There were 69 drawn in a circle about 10 cm. in diameter.

Exp. 27. Sabine.

	1″—40″				1″—40″			
R	3·30	3·45	3·25	2·75	3·25	3·25	3·30	3·20
P	——	——	13·5	14·75	13·0	13·0	12·5	12·5
	3·18				3·27			
	14·1				12·7			

1″—37″

3·40	3·40	2·60	3·23
13·5	13·75	13·5	14·4

3·15
13·7

During reaction: *R* is more regular and perhaps slightly inhibited. *V* falls. The respiratory oscillation is suppressed.

Exp. 28. Sabine.

	1″—40″				1″—42″			
R	3·20	3·30	3·00	3·0	3·55	3·46	3·10	3·27
P	13·0	12·5	12·5	12·25	13·75	13·25	13·0	12·7
	3·01				3·34			
	12·5				13·0			

1″—40″

3·00	3·05	3·05	3·30
14·5	13·75	13·0	12·5

3·10
13·3

During reaction: *R* is markedly inhibited, more at first than afterwards. *V* falls noticeably. The respiratory oscillation is suppressed.

Exp. 29. Sabine.

	1″—40″				1″—42″			
R	3·10	3·30	2·95	2·50	3·60	3·30	3·75	3·50
P	11·5	12·0	12·5	13·0	12·75	12·5	12·3	12·7
	2·96				3·53			
	12·2				12·6			

1″— 38″

3·00	2·30	2·95	3·50
13·75	13·5	12·75	12·8

2·93
13·2

During reaction: *R* is inhibited. *V* is diminished. The respiratory oscillation is suppressed.

Exp. 30. Baird.

	1″— 40″				1″— 28″			
R	2.60	2.65	2.35	2.60	2.40	2.50	2.50	2.50
P	12.0	13.0	11.75	12.5	12.0	11.75	11.75	12.1
	2.55				2.47			
	12.3				11.9			

1″— 50″

2·75	2·45	2·40	2·50	2·25
12.25	12.5	12.5	12.5	13.0

2·47
12·5

During reaction: *R* is inhibited. The plethysmograph functioned as a sphygmograph.

Exp. 31. Baird.

	1″— 40″				1″— 40″			
R	2.40	2.10	2.45	2.40	2.45	2.25	2.75	2.45
P	12.5	12.5	12.5	12.75	12.5	12.0	12.0	11.5

2·33
12·5

2·47
12·0

1″— 50″

2.60	2.45	2.45	2.25	2.65
12.5	12.0	12.0	12.25	12.5

2·48
12·5

During reaction: *R* is inhibited; *V* falls at first, but rises gradually to the end of the reaction.

Exp. 32. Miss Jenkins.

	1″— 50″					1″— 40″			
R	2.80	3·05	3·15	3·50	3·45	4·00	3·90	3·90	4·25
P	——	13·5	12·75	13·0	13·0	12·75	13·25	13·25	13·50

3·19
13·0

4·00
13·1

1″— 40″

4·00	3·80	3·75	3·90
13·5	13·75	13·0	13·0

3·86
13·3

During reaction: *R* is markedly inhibited. *V* is unchanged, except for a slight fall after the first signal.

Exp. 33. Miss Jenkins.

	1″— 40″				1″— 40″			
R	3·70	3·85	3·80	3·00	3·80	3·95	3·75	3·75
P	13·0	12·0	13·0	13·75	12·75	13·0	13·5	13·1

3·58
12·9

3·86
13·0

1″— 55″

3·70	3·75	3·50	3·55	3·60
13·75	13·5	13·5	13·5	13·0

3·60
13·4

During reaction: *R* is inhibited. *V* is very slightly diminished. The respiratory oscillation is markedly suppressed.

EXP. 34. MISS JENKINS.

	1″—40″				1″—40″			
R	3·75	3·40	3·00	3·40	3·60	3·90	3·50	3·75
P	13·5	13·5	13·5	13·0	13·0	12·75	12·0	12·5
	3·38				3·68			
	13·7				12·56			

1″—50″

3·85	3·75	3·55	3·55	3·30
12·5	12·8	12·3	12·5	12·5

3·60
12·52

During reaction: *R* is inhibited very slightly. The respiratory oscillation is slightly suppressed. *V* is not changed.

EXP. 35. MISS ANDRUS.

	1″—39″				1″—40″			
R	3·70	3·60	3·55	3·60	3·75	3·50	3·75	3·75
P	13·5	13·1	13·8	13·2	14·0	14·2	13·5	13·8
	3·61				3·69			
	13·4				13·7			

1″—40″

3·70	3·15	3·20	3·70
12·0	12·8	12·7	12·5

3·44
12·5

During reaction: height of *R* is increased. *Cf.* Exps. 8 and 24 for deeper breathing during attention in the same *O*. *Cf.* also Exps. 25 and 26 for inhibited breathing during attention. There is a marked fall in *V*.

EXP. 36. MISS ANDRUS.

	1″—40″				1″—40″			
R	3·40	3·35	3·00	3·05	3·30	3·35	3·35	3·40
P	13·6	12·9	12·6	13·0	13·8	14·3	14·6	14·0
	3·20				3·62			
	13·0				14·2			

1″—49″

3·30	2.25	2.50	2.95	2.90
13·5	13·1	12·0	12·7	12·9

2.74
12·8

During reaction: Height of *R* is increased. *V* is more markedly decreased than in the last experiment.

Summary of Results.

Attention involved in counting radii of circle is characterized by

i. Unequivocally increased rate of *R* (8 out of 10 cases). In 2 cases (same *O*), *R* is once slower than normal, but same as the recovery; and once it is greater than the normal, but very slightly less than the recovery.

ii. Unequivocal slowing of *P* (3 out of 10 cases, 2 by same *O*).

Unequivocal increase (2 out of 10 cases).

In 4 cases reaction *P* is faster than normal but slower than recovery. In 1 case, it is faster than recovery but slower than normal.

iii. Inhibited breathing (8 out of 10 cases); deepened breathing in same *O* in two instances.

iv. Suppression of respiratory oscillation where it occurs.

v. Fall in *V* (7 out of 10). 2 cases unchanged; 1 case *V* not recorded.

At this point, it was suggested that the experiments should be taken as a part of the day's work and be worked through mechanically. Two variations were devised: (i) an experiment in the performance of which *O* should have an intrinsic interest, *e. g.*, looking for an illusion in the radii of a circle; and (ii) an experiment which should involve the peculiar interests of *O*; *e. g.*, a question in philosophy for a student of philosophy. The first variation was carried out with the radii of a circle with a view to detecting an illusion in the lines; and also with the after-image stimulus with a view to marking the periodicity of the after-image.

4. Stimulus: Suggested Illusion in the Radii of a Circle. *O* was asked to discover the illusion.

EXP. 31. BAIRD.

	1″—48″					1″—48″				
R	2.25	2.00	2.10	2.10	2.20	2.30	2.45	2.15	2.60	2.50
P	11.0	11.0	11.0	11.0	10.9	10.5	10.6	11.0	11.0	10.3
	2.13					2.40				
	10.9					10.6				

	1″—35″			
	1.50	2.25	2.40	2.40
	11.0	10.4	10.5	19.5
	2.13			
	10.6			

During reaction: *R* is markedly inhibited. The respiratory oscillation is suppressed. There is no *V* change, since the plethysmograph functioned as a sphygmograph.

EXP. 38. BAIRD.

	1″—30″			1″—26″		
R	2.85	2.50	2.75	2.50	2.50	2.16
P	11.5	11.0	11.5	11.4	10.7	11.0
	2.70			2.38		
	11.3			11.0		

1″— 68″

2.75	2.75	2.30	2.50	2.30	2.10	2.30
11.7	11.5	11.4	10.9	11.4	11.2	11.2

2.42
11.3

During reaction: *R* is markedly inhibited. The respiratory oscillation is suppressed. The plethysmograph functioned as a sphygmograph.

EXP. 39. BAIRD.

	1″— 37″				1″— 22″		
R	2.30	2.10	2.50	2.57	2.60	2.50	2.41
P	11.0	11.6	11.5	10.7	12.0	11.5	11.6
	2.36				2.50		
	11.2				11.7		

1″— 65″

2.85	2.45	2.50	2.45	2.20	2.30	2.50
12.0	11.0	11.3	11.0	11.0	10.8	10.6

2.46
11.1

During reaction: *R* is greatly inhibited. The plethysmograph functioned as a sphygmograph.

EXP. 40. SABINE.

	1″— 40″				1″— 32″		
R	3.10	2.80	3.40	2.60	3.50	3.20	3.41
P	——	14.6	15.0	15.25	14.75	13.6	13.7
	3.10				3.37		
	14.9				13.9		

1″— 50″

3.60	3.55	2.80	3.60	3.10
14.5	14.5	15.25	15.0	15.25

3.35
14.9

During reaction; *R* is slightly inhibited toward the end. There is no change in *V* except a very slight fall after the initial and final signals. *O* reported that he thought of the illusion during the normal. Notice the inhibited breathing and suppressed respiratory oscillations during the last 20″ of the normal. The rates of *R* and *P* are slowed and quickened respectively. This change, however, is opposed to that of the reaction.

EXP. 41. SABINE.

	1″— 40″				1″— 42″			
R	2.90	3.00	3.05	3.05	3.50	3.20	3.05	3.37
P	——	——	14.0	14.5	14.0	14.25	13.75	14.1
	3.00				3.28			
	14.2				14.0			

1″— 55″

3.50	2.10	3.05	2.25	2.35	4.00
14.2	15.2	15.0	15.0	15.5	14.0

2.87
14.8

During reaction: *R* is markedly inhibited (after three initial normal respirations). The respiratory oscillation is suppressed. *V* remains constant.

EXP. 42. MISS JENKINS.

	1″— 34″				1″— 44·5″				
R	3·00	2·45	3·05	2·75	3·50	4·00	3·95	3·70	4·00
P	12·5	12·0	12·0	12·5	12·5	13·5	13·0	12·5	12·5
		2.81					3.83		
		12.2					12.8		

1″— 49·5″

3·70	3·60	3·90	3·80	3·41
12·0	12·5	12·0	12·0	12·3

3.68
12.1

During reaction: *R* is somewhat inhibited. *V* is constant except for a slight fall after the signals at the beginning and end of the reaction. *O* reports that during recovery she tried to imagine what the illusion was; she was, therefore, attentive. This fact may account for the fast rate of *R* in recovery.

EXP. 43. MISS JENKINS.

[A control record was taken between exps. 42 and 43 to discover whether *O* was reacting normally. The slow normal rate of *R* in exp. 42 was unusual. The results show that normal *R* in exp. 42 is too slow—2.81 against 3.39 in the control record. The rate of pulse is practically the same—12.2 against 12.1 in the control.]

	1″— 40″				1— 39″			
R	3·70	3·90	3·20	3·30	3·65	3·85	3·90	3·61
P	12·5	12·7	12·0	11·5	11.25	12.25	12·5	11·9
		3·47					3·75	
		12.1					11.97	

1″— 58″

3·90	3·50	3·60	3·30	3·75	3·50
11·6	12·0	12·0	12·3	13·5	11·8

3·70
11·94

During reaction: *R* is slightly inhibited at first and afterwards becomes normal. There are no *V* changes.

Summary of Results.

Attention to radii of circle with intrinsic interest is characterized by:

i. Unequivocally increased rate of *R* (6 out of 7 cases). In 1 case *R* is unequivocally slowed.

ii. Unequivocally decreased rate of *P* (3 out of 7 cases). Unequivocally increased rate of *P* (2 out of 7 cases). In 2 instances, the rate of *P* of reaction is less than normal, and in 1 case the same as that of recovery: in the other case, more than rate of recovery.

iii. Inhibited breathing in every case; but usually not marked.

iv. Fall in volume only after signals.

5. The fixation and after-image experiments were reproduced with intrinsic interest. *O* was required to mark the periodicity of the after-image.

EXP. 44. SABINE.

1″— 40″

R	2·95	3·03	3·05	3·40
P	12·5	12·5	12·5	12·0

3·11
12·3

1″— 33″			1″— 47″					1″— 10″
3·35	3·25	3·33 :	3·25	3·10	2·95	3·00	2·85	3·05
12·0	12·25	12·3 :	12·75	12·0	13·0	13·0	12·5	12·5
		3·31	3·17	3·03				3·05
		12·1	12·4	12·6				12·5

During reaction: *R* is not inhibited during fixation; but is markedly inhibited during after-image. There is a fall in *V* after each signal.

EXP. 45. SABINE.

1″—40″				1″—20″			1″—21″	
R	3·05	3·30	2·95	2·95	3·45	3·22 :	3·40	2·95
P	12·0	12·0	12·0	11·75	12·0	12·0 :	12·0	11·75
		3·08			3·33		3·25	3·17
		11·93			12·0		11·93	11·87

1′—52″

3·45	3·00	3·25	3·30	2·85
12·75	14·0	13·0	12·5	11·8

3·17
12·8

During reaction: in fixation the height of *R* is not much changed; during after-image *R* is markedly inhibited. *V* is slightly less during reaction.

EXP. 46. SABINE

1″—38″				1″—20″			1′—19″	
R	3·75	3·45	3·55	3·75	3·50	3·40 :	3·25	3·38
P	12·75	12·0	12·25	13·4	12·0	13·75 :	11·75	12·1
		3·62			3·45		3·37	3·29
		12·6			12·4		12·1	11·9

1″—48″

3·05	3·30	3·50	3·20	3·00
12·0	12·25	12·0	12·0	11·5

3·21
11·9

During reaction: in fixation *R* is normal; but inhibited during after-image—more at the beginning than at the end. *V* falls sharply after the first and last signals; it is lower during after-image than during fixation phase. There is a sharp rise in *V* in the middle of fixation.

EXP. 47. MISS JENKINS.

	1″—41″				1″—21″			1″—23″	
R	2.90	3.25	3.30	3.63	3.70	4.00 :	4.00	4.00	3.75
P	11.75	12.25	12.25	13.1	13.25	12.25 :	12.25	12.6	12.2
		3.27				3.85	3.81		3.91
		12.3				12.75	12.54		12.34

1″—40″

4.50	4.00	3.90	3.60
12.25	12.25	12.3	12.0
	4.00		
	12.2		

During reaction: *R* is normal for fixation; but is inhibited for after-image. There are no *V* changes in this and the three following experiments because the plethysmograph functioned as a sphygmograph. Respiratory oscillations are suppressed throughout reaction, but more during after-image than during fixation.

EXP. 48. MISS JENKINS.

	1″—41″				1″—22″		1″—22″	
R	3.60	3.25	3.85	4.36	4.00	3.81 :	3.80	3.90
P	12.8	12.25	12.75	12.9	12.0	12.0 :	12.0	12.0
		3.76			3.90	3.87		3.85
		12.6			12.0	12.0		12.0

1″—46″

4.00	3.95	3.95	3.30	4.00
12.1	12.75	13.0	12.75	12.5
		3.84		
		12.6		

During reaction: *R* is somewhat inhibited during whole of reaction; but more during after-image than fixation. The respiratory oscillation is slightly suppressed.

EXP. 49. BAIRD.

1″— 37″

R	2.55	2.50	2.50	2.78
P	12.5	12.5	12.75	12.5
		2.58	
		12.56	

	1″— 30″			1′—29″			1″—30″		
	2.25	2.50	2.50 :	2.60	2.50	2.22	1.85	2.25	2.55
	12.55	12.56	12.55 :	12.55	12.0	11.4	12.0	11.4	11.2
		2.41	2.42	2.44			2.21		
		12.57	12.21	11.85			11.53		

During reaction: the result of this curve is inconclusive, as the rates show a gradual falling-off throughout the experiment. There is no apparent change in depth of breathing.

EXP. 50. BAIRD.

	1″—37″				1″— 20″		1′—18″	
R	2.20	2.60	2.40	2.43	2.55	3.00 :	2.75	2.50
P	12.5	12.75	12.6	12.5	13.0	12.6 :	12.0	11.25
		2.40				2.77	2.70	2.60
		12.5				12.8	12.2	11.6

1″—55″

2.75	2.00	2.00	2.25	2.40
11.8	11.8	11.6	11.8	11.6

2.28
11.7

During reaction: *R* is inhibited throughout; but much more during after-image than fixation.

Summary of Results.

Attention to fixation and after-image, with intrinsic interest, is characterized by:

i. Unequivocally increased rate of *R* (4 out of 7 cases). In 1 case *R* is slower than normal but greater than recovery. In 2 cases greater than normal but less than recovery. In 5 out of 7 cases, the fixation rate is greater than the after-image rate; in 2 out of 7, slower (only slightly).

ii. Unequivocally increased rate of *P* (1 out of 7 cases). Unequivocally decreased rate of *P* in 1 out of 7 cases. In 1 case *P* is unchanged. In 2 out of 7 cases *P* is faster than normal, but less than recovery. In 2 out of 7 cases *P* is slower than normal, but faster than recovery. The pulse changes in rate with respect to normal and recovery are inconclusive. But with reference to the fixation and after-image rates of *P*, the fixation rate is faster than the after-image rate in 5 out of 7 cases, one case unchanged, one case slower.

iii. Inhibited breathing. There is more inhibition during after-image than during fixation (6 out of 7 cases). 1 case is unchanged.

iv. Very slight fall in *V*.

These results, compared with the results without intrinsic interest, yield the following points of agreement and disagreement.

They agree in

i. Increased rate of *R* and the division of increase (6 cases each) between fixation and after-image phases.

ii. Inconclusive reaction of *P;* but rate of *P* in fixation is greater than the after-image.

iii. Inhibited *R*.

iv. Slight fall in arm volume.

They differ in that

i. Without intrinsic interest, *R* is inhibited more in fixation; while with intrinsic interest, the after-image phase is the more inhibited.

ii. With intrinsic interest, *R* is increased more in fixation than during after-image.

6. Stimulus: Questions in Philosophy.

The following six experiments were made with a view to

comparing the physiological reactions of attention with natural interest with the attentional reactions in which other interests are involved. (See above, Exp. 37.)

EXP. 51. SABINE.

Question: Arrange in order of birth a list of six philosophers (Leibnitz, Spinoza, Locke, Hume, Kant, Descartes). *O* was required to signal when the question was satisfactorily answered.

	1″— 40″				1″— 41″			
R	3·75	3·25	3·35	2·65	3·10	3·60	3·20	2·90
P	13·0	13·25	13·1	12·5	12·0	12·25	12·5	12·7
	3·25				3·20			
	12·96				12·37			

1″— 48″

3·05	3·05	2·75	3·5	3·25
——	——	13·0	13·75	13·4

3·12
13·0

During reaction: *R* is inhibited more during the middle of reaction than at the beginning or end. The plethysmograph functioned as a sphygmograph during this and the next three experiments. *O* reports that he had expected an easy question; he was surprised by the names, and at first somewhat confused. Attention became more intense toward the end of the reaction. During the recovery he thought of the series again.

EXP. 52. SABINE.

Question: The relation of mind to body in Descartes' system.

	1″— 40″				1″— 44″				
R	3·40	3·20	2·70	2·60	3·05	3·25	3·05	3·40	3·00
P	11·75	11·25	12·25	12·5	12·75	12·6	12·0	12·1	11·7
	2·97				3·15				
	11·9				12·23				

1″— 48″

3·60	3·40	3·25	3·25	3·37
12·6	12·3	12·1	12·1	——

3·37
12·27

During reaction: *R* is inhibited. *O* reports curiosity as to what the question would be. He had difficulty in thinking himself into Descartes' system. He attended to the question in an indistinct sort of way during the recovery.

EXP. 53. MISS JENKINS.

Question: Same as in last experiment.

	1″— 46″					1″— 39″			
R	3·25	3·05	3·40	3·55	4·00	4·50	4·25	3·75	4·38
P	13·75	14·75	13·5	13·5	12·9	13·2	13·3	12·9	13·1
		3·45					4·22		
		13·6					13·1		

1″— 27″

4.05 4.00 3.50
13.0 13.4 12.8

3.85
13.0

During reaction: *R* is inhibited.

EXP. 54. MISS JENKINS.

Question: Malthus' doctrine of population and food supply.

	1″—37″				1″—37″			
R	4.00	3.90	3.25	2.14	3.90	4.00	3.75	3.57
P	13.5	——	13.5	14.0	13.1	13.0	13.1	12.8
	3.32				3.80			
	13.6				13.0			

1″—50″

3.75 2.95 3.00 3.05 3.10
13.2 13.6 12.5 12.5 12.6

3.17
12.8

During reaction: *R* is inhibited, but more during the first half than in the last. The inhibition continues for 14″ in the recovery.

EXP. 55. BAIRD.

Question: Arrange names of philosophers, as in Exp. 51.

	1″—55″						1″—20″	
R	2.80	2.60	2.20	2.75	2.70	2.80	2.50	2.90
P	11.9	11.4	11.4	11.7	11.5	11.8	11.7	11.7
			2.64				2.70	
			11.6				11.7	

1″—58″

2.95 2.70 2.30 2.55 2.50 2.70
—— 11.6 11.5 11.4 11.0 11.1

2.61
11.3

During reaction: *R* is decidedly inhibited. *V* sinks greatly. *O* reports that the question was easy.

EXP. 56. BAIRD.

Question: Relation of mind to body in Descartes' philosophy.

	1″—36″				1″—38″			
R	3.00	2.50	2.45	2.60	3.00	2.50	2.75	2.50
P	11.9	11.5	11.9	12.0	11.9	11.7	11.2	11.2
			2.63				2.68	
			11.8				11.5	

1″—55″

2.90 2.45 2.40 2.30 2.50 3.00
11.3 11.1 10.5 10.8 10.6 11.0

2.59
10.9

During reaction: *R* is inhibited and *V* falls very decidedly. *O* re-

ports that there was a slight unpleasantness during recovery, since he could not get his mind off the subject.

Summary of Results.

Attention with natural interest is characterized by:

i. Unequivocally increased rate of *R* (4 out of 6 cases).

In 1 case rate of reaction *R* is less than normal and greater than recovery. In 1 case rate of *R* is greater than normal and less than recovery. Both reactions are from the same *O*.

ii. Unequivocally faster *P* (1 out of 6 cases).

Unequivocally slower *P* (1 out of 6 cases).

In 1 case *P* is faster than normal, and less than recovery.

In 3 cases *P* is greater than recovery, and less than normal.

iii. Inhibited breathing in every case.

iv. Fall in *V* in each of the two cases in which the plethysmograph functions properly.

II. Attention to Auditory Stimuli.

1. Stimulus: Difference tone. Attention was directed to a difference tone produced by Quincke's tubes, g^3–b^3. The tone was very prominent. *O* signalled when the difference tone was heard.

EXP. 57. GALLOWAY.

	1″—53″						1″—17″	
R	3.20	3.30	3.00	3.30	3.25	3.33	2.95	3.28
P	——	——	14.3	14.2	14.0	14.0	14.0	15.0
			3.26				3.11	
			14.1				14.5	

1″—60″

3.70	3.75	3.55	3.75	3.75	3.40	
14.5	14.7	13.5	14.0	13.5	14.0	
		3.65				
		14.0				

During reaction: *R* is not much inhibited. *V* first rises slightly, then falls decidedly. *O* reports a feeling of strain and a tendency to hold the breath.

EXP. 58. SABINE.

	1″—25″			1″—7.5
R	3.70	3.25	3.80	4.00
P	15.8	16.2	15.6	15.6
	3.58			4.00
	15.8			15.6

1″—70.5″

3.80	3.70	3.30	4.00	3.90	3.75	3.30	
15.8	16.6	14.8	15.0	15.9	16.1	15.2	
			3.68				
			15.6				

During reaction: *R* is greatly inhibited, but the respiratory oscillation is not much suppressed. *V* falls, reaching a minimum after the end of the reaction; and then returns rather slowly to normal.

EXP. 59. MISS JENKINS.

	1″—36″				1″—6″		1″—29″		
R	3.55	3.80	4.75	4.91	4.83		4.50	4.55	4.20
P	——	15.3	15.5	15.0	14.8		14.8	15.2	14.3
		4.25			4.83			4.41	
		15.2			14.8			14.7	

During reaction: *R* is slightly inhibited. *V* tends to fall; it reaches a minimum after the reaction.

EXP. 60. BAIRD.

	1″—40″				1″—10.5″	
R	2.30	2.40	2.20	2.75	2.85	2.38
P	15.4	14.7	15.2	15.4	14.4	14.6
		2.41			2.85	
		15.1			14.4	

	1″—41.5″			1″—9″	1″—20″	
	2.55	2.96	2.68	2.00	2.20	2.10
	14.7	14.6	14.9	15.0	13.9	13.8
		2.64		2.00	2.15	
		14.7		15.0	13.8	

During reaction: *R* is inhibited. *V* falls in both reactions, and attains a minimum after the reaction.

EXP. 61. BAIRD.

	1″—30″			1″—6″		1″—37″			1″—7.5″	1″—8.5″
R	2.85	2.35	2.45	2.25	2.00	2.45	2.50	2.64	2.53	2.52
P	10.9	11.0	11.4	11.0	11.0	10.9	10.5	10.5	11.3	10.5
		2.55		2.25		2.39			2.53	2.52
		11.1		11.0		10.7			11.3	10.5

During reaction: *R* very slightly inhibited. There is no appreciable change in *V*. *O* reports low degree of attention.

EXP. 62. GALLOWAY.

	1″—39″				1″—14″		1″—20″	
R	3.75	3.25	3.75	3.83	3.60	4.00	4.40	4.05
P	15.6	13.7	14.8	14.0	14.2	14.7	14.4	14.5
		3.64			3.80		4.22	
		14.5			14.45		14.45	

During reaction: *R* is slightly inhibited at the end of the reaction. There is no definite change in *V*. *O* reports that he was confused because one of the pipes at first failed to sound. He was not comfortable because the room was too cold.

Summary of Results.

Attention to difference tone is characterized by:

i. Unequivocal increase in rate of *R* (4 out of 8 cases). Unequivocal decrease in rate of *R*. 3 out of 8 cases.

In 1 case the rate of R is faster than recovery, but less than that of normal.

ii. Unequivocal increase in rate of P (3 out of 8 cases). Unequivocal decrease in rate of P (1 out of 8 cases). In 2 cases the rate of P is faster than recovery, but less than normal. In 2 cases the rate of P is the same as recovery, but less than normal.

iii. Inhibited respiration in every case, although in some cases only slightly.

iv. Fall in V in 5 out of 8 cases. In 2 cases V is unchanged; in one case it rises, falls, and rises again.

It may be questioned whether it was advisable to attempt two reactions during the same experiment, as was done in Exps. 61 and 62. The second reaction in both experiments has changes opposite to those of the first reaction. However, there is precedent for the procedure in Zoneff and Meumann's work.

2. Stimulus: Watch-tick receding and coming in. O signalled when the watch ceased to be audible and when it again became audible.

EXP. 63. GALLOWAY.

	1″—45″					1″—12″
R	3.60	2.90	3.10	3.10	3.00	2.45
P	14.1	——	14.2	14.9	14.4	15.0
			3.04			2.45
			14.1			15.0

1″—73″

3.75	3.60	3.50	3.65	3.75	3.40	2.75	3.00
15.5	14.5	14.9	14.7	14.2	14.2	13.6	14.0

3.42
14.4

During reaction: R is greatly inhibited; indeed almost suppressed. V falls greatly at the beginning of the reaction, and remains low for 25 after the reaction.

EXP. 64. SABINE.

	1″—40″				1″—15″		
R	4.00	3.45	3.25	3.90	4.10	3.80	4.00
P	15.1	14.7	15.2	15.9	15.0	16.2	15.6
		3.65				3.96	
		15.2				15.6	

1″—72″

4.30	4.00	3.90	3.90	4.00	3.30	3.75	
16.6	15.9	15.2	15.0	15.5	14.6	——	

3.88
15.4

During reaction: R is greatly inhibited; in fact, almost completely suppressed. V falls moderately and soon rises to normal.

Exp. 65. Baird.

	1″—40″				1″—41″			
R	2.90	2.65	2.20	2.85	2.65	2.75	2.55	2.50
P	12.6	12.6	12.0	12.1	11.9	12.5	12.3	12.5
	2.65				2.61			
	12.4				12.3			

1″—48″

2.50	2.65	2.55	2.60	2.43
12.5	12.0	12.0	11.9	11.6

2.54
12.0

During reaction: *R* is greatly inhibited. *V* falls decidedly.

Exp. 66. Baird.

	1″—40″				1″—36.5″			
R	2.70	2.20	2.75	2.75	3.00	2.75	2.50	2.23
P	——	12.7	13.2	12.4	11.8	11.8	11.9	11.2
	2.60				2.62			
	12.7				11.6			

1″—55.5″

2.71	2.35	2.20	2.10	2.25	2.50	
12.0	12.1	11.4	11.4	11.8	11.8	

2.35
11.7

During reaction: *R* is markedly inhibited, although more at the beginning than at the end. The respiratory oscillation is suppressed. *V* falls slowly, and reaches a minimum after the end of the reaction.

Exp. 67. Galloway.

	1″—37″				1′—12′		
R	2.90	2.55	2.60	2.85	3.70	3.50	2.50
P	15.7	16.6	16.3	16.7	15.2	16.0	14.5
	2.72				3.23		
	16.3				15.2		

1″—82′

3.65	3.25	3.20	3.25	2.75	3.00	2.75	2.66
16.5	16.5	16.2	16.2	15.6	16.0	15.7	15.3

3.06
16.0

During reaction: *R* is greatly inhibited. *V* falls sharply, reaching a minimum at the middle of the reaction.

Exp. 68. Sabine.

	1′—48′					1″—28″		
R	2.90	3.05	3.60	3.40	3.75	3.75	3.25	3.50
P	13.7	13.2	13.4	13.7	14.1	12.9	11.3	11.0
		3.34				3.50		
		13.6				11.7		

1″—50″

3.25 3.20 3.10 3.00 3.40
13.7 13.6 12.6 12.5 12.4

3.19
12.9

During reaction: *R* is decidedly inhibited. *V* falls very slightly during the first half of the reaction, rising during the second half. The reaction is followed by several very deep *R*; *V* falls at this place.

EXP. 69. MISS JENKINS.

	1″—34″			1″—18″		1″—50″				
R	4.20	4.80	5.25	5.65	5.00	5.35	5.30	5.00	5.25	5.05
P	13.0	13.8	15.7	13.9	13.2	15.0	14.4	——	——	13.6
	4.75			5.32		5.19				
	14.1			13.5		14.3				

During reaction: *R* is inhibited progressively as the watch moved out, reaching a minimum at the limen. *V*, which had been low during the normal, rises markedly.

Summary of Results.

Attention to watch-tick receding and coming in is characterized by:

i. Unequivocally increased rate of *R* (5 out of 7 cases). Unequivocally decreased rate of *R* (1 out of 7 cases).

In 1 out of 4 cases *R* is greater than recovery but less than normal.

ii. Unequivocally decreased rate of *P* (4 out of 7 cases). Unequivocally increased rate of *P* (2 out of 7 cases).

In 1 case *P* is less than normal but more than recovery.

iii. Very great inhibition of *R*.

iv. Very marked fall in *V*, in 6 out of 7 cases; in one case, Exp. 69, there is a rise in *V*.

3. Stimulus: Watch-tick coming in and receding. *O* signalled when the watch became audible and when it ceased to be audible.

EXP. 70. SABINE.

	1″—35″				1″—22″			
R	4.00	3.60	3.40	3.80	3.20	3.20	3.80	3.50
P	14.9	14.8	15.5	15.4	14.2	13.4	13.4	13.6
	3.70				3.42			
	15.1				13.6			

1″—68″

4.00 4.00 4.10 3.90 3.55 3.90 3.43
14.7 15.1 14.8 14.9 14.2 13.8 13.8

3.84
14.4

During reaction: *R* is almost completely suppressed. There is a slight deepening in *R* at the moment when the sound is distinctly

audible, between the coming in and the going out of the stimulus. *V* falls gradually, reaching a minimum about the middle of the reaction; it begins to return to the normal before the end of the reaction.

EXP. 71. BAIRD.

1″—64.5°

R	2.35	2.35	2.30	2.30	2.45	2.40	2.00
P	12.8	12.5	12.6	12.5	12.6	12.4	12.6

2.30
12.5

1″—37.5″				1″—22″	
2.10	2.50	2.50	1.46	2.00	1.91
12.5	12.3	12.5	11.7	11.2	11.6
2.14				1.95	
12.2				11.4	

During reaction: *R* is strongly inhibited. *V* is greatly diminished, attaining a minimum after the end of the reaction. Note that the rates of *R* in the reaction are least at the beginning and end, where the attention to the stimulus must have been greatest, because the stimulus at those points was weakest.

EXP. 72. GALLOWAY.

	1″—20″		1″—18″		1″—14″	
R	3.25	3 20	3.25	3.31	3.15	3.00
P	16.4	16.1	14.9	15.9	16.5	16.2
	3.22		3.28		3.07	
	16.2		15.1		16.3	

During reaction: *R* is almost completely suppressed; *V* falls precipitately. (G.'s reactions on this day were not good, as it was difficult to obtain a quiescent normal.)

EXP. 73. SABINE.

	1″—55″						1″—19″		
R	3.30	3.35	3.35	3.30	3.20	3.60	3.70	3.30	3.50
P	13.9	13.4	13.3	13.4	12.9	13.2	13.4	12.6	11.7
			3.36				3.16		
			13.3				12.5		

1″—53″

3.35	3.00	3.10	3.50	3.12
13.3	14.5	13.6	12.7	12.2

3.21
13.2

During reaction: *R* is markedly inhibited both during the coming in and the going out of the watch, with a deep inspiration between. *V* is slightly less.

EXP. 74. MISS JENKINS.

	1″—25″			1″—16″		1″—40″			
R	5.35	5.20	5.50	4.95	4.65	5.40	5.70	5.00	5.00
P	——	——	14.0	13.6	13.1	14.0	——	——	——
	5.35			4.77			5.27		
	14.0			13.3			14.0		

During reaction: *R* is uniformly inhibited. *V*, which had been low before the reaction, rises during the reaction; it falls again after the reaction.

Summary of Results.

Attention to watch-tick coming in and going out is characterized by:

i. Unequivocally increased rate of *R* (1 out of 5 cases). Unequivocally decreased rate of *R* (3 out of 5 cases).

In 1 case *R* is slower than normal, but faster than recovery.

ii. Unequivocally increased rate of *P* in no case. Unequivocally decreased rate of *P* (4 cases out of 5).

In 1 case *P* is slower than normal, but faster than recovery.

iii. Inhibited *R* in every case.

iv. Diminished *V* in every case but one, which gave a rise.

Compared with the results of Exps. 63-70, there is one difference, *viz.*, that the rate of *R* is increased in the former experiments, but is decreased in these.

4. Stimulus: Fork *C* of 256 vibs. *O* was required to mark the moment at which the tone ceased to be audible.

EXP. 75. MISS JENKINS.

	1″—33″				1″—8″		1″—42.5″			
R	4.20	4.90	4.60	5.00	4.7		4.20	5.00	5.40	4.80
P	——	15.0	15.1	15.6	15.0		15.0	16.0	16.0	——
		4.67			4.7			5.02		
		15.2			15.0			15.6		

	1″—8″	1″—36.5″			
	5.00	4.76	4.20	4.35	4.10
	——	14.8	14.1	13.7	15.2
	5.00	4.35			
	——	14.4			

During reaction: *R* is inhibited for both reactions. *V* falls for the first reaction, attaining a maximum after the second signal. The stylus of the plethysmograph did not write during the second reaction.

EXP. 76. BAIRD.

	1″—46″					1″—12″	1″—25″		
R	2.80	2.85	2.65	2.60	3.00	2.33	2.60	2.65	2.60
P	13.5	13.5	13.6	13.4	14.0	12.9	13.0	13.0	13.0
		2.78				2.33		2.61	
		13.4				12.9		13.0	

	1″—14″		1″—34″		
	2.50	2.25	2.50	2.50	2.40
	12.6	12.25	12.6	12.5	12.5
	2.37		2.46		
	12.4		12.5		

During reaction: *R* is inhibited for both reactions. *V* falls sharply in both cases, and also after the second signal, which marked the close of the reaction.

EXP. 77. GALLOWAY.

	1″—35″				1″—16″		1″—24″		
R	4.30	4.10	4.00	4.00	4.00	3.33	4.45	4.50	4.10
P	15.5	16.2	16.4	16.4	16.6	16.1	16.8	17.0	16.7
		4.10			3.66			4.35	
		16.1			16.3			16.8	

During reaction: *R* is not inhibited at first; but becomes increasingly inhibited. *V* is not much changed; but tends to increase.

EXP. 78. SABINE.

	1″—40″				1″—15″		
R	3.75	3.60	3.65	3.95	3.90	4.00	3.50
P	——	17.0	17.0	17.5	16.6	16.0	15.0
		3.73				3.80	
		17.6				15.8	

1″—70″

3.90	3.90	3.50	2.75	3.30	3.75	3.30	
17.0	17.0	17.5	17.8	17.0	17.6	16.0	
			3.53				
			17.1				

During reaction: *R* is inhibited. The respiratory oscillation is suppressed. *V* falls slightly; but falls more sharply after the second signal at the end of the reaction.

EXP. 79. BAIRD.

	1″—43″				1″—13″
R	2.50	2.55	2.85	2.30	2.16
P	12.9	12.7	13.0	12.1	12.1
		2.55			2.16
		12.6			12.1

1″—70″

2.50	2.40	2.35	2.35	2.65	2.25	2.40	
12.7	12.4	13.0	13.0	12.8	12.7	12.0	
			2.41				
			12.5				

During reaction: *R* is markedly inhibited. *V* falls slowly, reaching a minimum after the second signal.

EXP. 80. BAIRD.

	1″—45″					1″—15″		
R	2.60	2.40	2.75	2.75	2.60	2.00	2.20	2.50
P	12.8	12.9	12.9	13.4	12.8	12.4	13.0	13.4
		2.62					2.23	
		12.9					12.9	

1″—39″

2.25	2.50	2.60	2.55	
13.0	12.8	12.5	12.2	
		2.47		
		12.6		

During reaction: *R* is greatly inhibited. *V* does not fall very much. *V* rises greatly in recovery.

EXP. 81. GALLOWAY.

	1″—39″				1″—14″		
R	3.10	3.15	3.00	3.33	3.60	3.40	1.00
P	——	14.1	14.4	14.5	15.4	15.0	13.7
		3.14				2.66	
		14.3				14.7	

1″—70″

3.40	3.70	3.70	3.50	3.55	3.00	3.05	
15.6	15.8	15.8	15.7	15.3	14.4	13.8	
			3.41				
			15.2				

During reaction: *R* is inhibited; much more at the end of the reaction than at the beginning. The rates of *R* and *P* show a progressive slowing; so that, although the average rate of *P* is greater than normal, the last rate is decidedly less. It would seem that the tone, when strong, had produced an acceleration of pulse and respiration; later, as the dying tone was attended to, a slowing of *P* and *R*. *V* falls moderately and slowly, attaining a minimum after the end of the reaction.

EXP. 82. GALLOWAY.

	1″—40″				1″—15″	
R	3.50	3.85	3.15	3.00	2.85	1.70
P	——	14.5	15.1	14.9	16.0	15.0
		3.10			2.27	
		14.8			15.5	

1″—70″

3.50	3.50	3.30	3.30	3.15	3.45	3.10	
15.5	15.7	16.0	15.4	15.5	14.5	15.0	
			3.32				
			15.3				

During reaction: *R* is again progressively inhibited. This progressive inhibition is characteristic of *G*'s curves, but not of those of the other *O*'s. *V* falls, and remains low for many seconds, rising only toward the end of the recovery.

Summary of Results.

Attention to dying tone is characterized by:

i. Unequivocally increased rate of *R* (2 out of 10 cases). Unequivocally decreased rate of *R* (7 out of 10 cases).

In 1 case *R* is faster than normal, but less than recovery.

ii. Unequivocally decreased rate of *P* (5 out of 10 cases). Unequivocally increased rate of *P* (1 out of 10 cases).

In 2 cases *P* is faster than normal, but less than recovery.

In 1 case *P* is the same as normal, but more than recovery.

In 1 case there was no record of *P* (Exp. 75).

In exps. 77, 81, 82, there is a noticeable tendency to slower *P*.

iii. Inhibited breathing. In general, more at the end of the reaction than at first.

iv. Fall in *V* in every case but one (Exp. 77).

Note that the same *O* gives the three cases of increased rate of *P*.

Note also that the three cases of increased rate of *R* in the summary are given by *two O*'s, Miss Jenkins and Sabine (Exps. 75 and 78).

5. Stimulus: Forks *C* of 256 and *C* of 256 vibs. The forks were slightly mistuned. *O* was required to count the number of beats.

EXP. 83. MISS JENKINS.

	1″—42″				1″—17″	
R	4.90	5.10	5.40	5.00	5.15	4.85
P	15.0	15.7	15.9	16.0	15.4	15.4
	5.10				5.00	
	15.6				15.4	

1″—46″

5.00	5.00	4.25	4.75	5.00	
14.8	15.0	15.0	15.5	15.0	
		4.80			
		15.0			

During reaction: *R* is somewhat inhibited. *V* falls very slightly after the beginning of the reaction, then rises. It falls again after the signal at the end of the reaction. *O* reports that she could not hear beats.

EXP. 84. BAIRD.

	1″—39.5″				1″—30″		
R	2.75	2.75	2.55	2.68	2.85	3.00	2.89
P	12.5	12.8	12.5	12.4	12.3	12.1	12.2
	2.68				2.91		
	12.5				12.2		

1″—55.5″

2.47	2.65	2.75	2.50	2.45	2.50	
12.1	12.3	12.2	12.1	11.9	11.8	
		2.55				
		12.0				

During reaction: *R* is inhibited more at the beginning than at end. *V* falls moderately. *O* reports that he heard the beats and started to count them, but that his signal distracted him, so that he lost count and gave up.

EXP. 85. GALLOWAY.

	1″—30″			1″—19.5″		
R	3.80	3.25	3.65	3.40	3.10	3.89
P	16.1	16.3	17.0	17.2	15.4	14.9
	3.56			3.46		
	16.4			15.8		

1″—75.5″

4.09	4.40	3.65	3.85	3.40	3.40	3.80	3.90	3.50	4.00	
15.9	17.1	17.2	16.4	16.4	17.8	15.8	17.2	16.2	17.8	
				3.79						
				16.7						

During reaction: *R* is progressively inhibited. *V* falls between the beginning and end of reaction, tending to rise toward the end. There is a fall in *V* after the second signal. During recovery *V* rises steadily until 25″ from the end; at that point it falls. *O* reports difficulty in getting hold of beats: that was unpleasant. During the last part of the recovery the arm-rest became very uncomfortable. The last 25″ of the recovery is divided into periods of 5″ each.

EXP. 86. SABINE.

	1″—44″					1″—22.5″		
R	3.30	3.00	3.50	3.50	3.00	3.80	3.85	3.63
P	16.0	16.0	16.0	16.5	16.7	15.6	15.2	15.0
	3.30					2.76		
	16.2					15.2		

1″—53.5″

3.23	3.40	3.15	3.40	4.49
16.1	16.7	15.8	16.2	15.8

3.53
15.9

During reaction: *R* is inhibited more during the first part of the reaction than the last. *V* falls deeply, attaining a minimum about the middle of the reaction. *O* reports that he misunderstood the directions, supposing that he was to hear a difference tone.

EXP. 87. BAIRD.

	1″—57″						1″—11″
R	2.40	2.30	2.50	2.35	2.65	2.57	2.09
P	10.3	9.8	10.4	10.2	10.8	10.5	10.1
			2.46				2.09
			10.3				10.1

1″—58″

2.40	2.35	2.20	2.15	2.05	1.85
10.0	10.0	9.8	9.6	9.4	9.1

2.16
9.6

During reaction: *R* is slightly inhibited at first; but is progressively suppressed. *V* at first rises, then falls considerably; the minimum is attained after the reaction.

EXP. 88. BAIRD.

	1″—63″							1″—21″		
R	2.20	2.25	2.20	2.50	2.00	2.00	2.00	2.25	2.20	2.45
P	10.0	10.1	9.7	10.2	10.1	10.0	10.0	10.0	10.1	9.5
			2.16						2.29	
			10.0						9.9	

1″—40″

1.95	2.10	1.90	1.75
10.5	10.7	10.2	9.2

1.92
10.1

During reaction: *R* is very greatly inhibited. *V* first rises, then falls precipitately.

EXP. 89. GALLOWAY.

1″—82″

R	3.20	3.00	3.30	3.00	3.30	3.70	3.25	3.25
P	14.5	13.9	——	14.7	14.8	14.9	14.2	14.1

3.25
14.4

1″—25″			1″—15	
3.25	2.70	3.50	3.25	2.90
14.3	——	——	——	13.4
3.11			3.07	
14.3			13.4	

During reaction: *R* is inhibited. *V* is diminished.

EXP. 90. SABINE.

	1″—50″					1″—13.5″
R	3.10	3.20	3.25	3.20	3.50	3.11
P	13.1	13.4	12.8	12.8	12.7	12.6
		3.25				3.11
		12.9				12.6

1″—73.5″

3.52	3.25	3.10	3.00	2.90	2.70	2.88
14.2	13.4	13.0	12.9	12.9	11.7	12.3

3.05
12.9

During reaction: *R* is markedly inhibited at the end of the reaction. *V* falls moderately; but falls more greatly and for a longer time after reaction. *O* reports that he heard no beats. (The wax was knocked from the flatted fork.)

Summary of Results.

Attention involved in counting beats is characterized by:

i. Unequivocally increased rate of *R* (2 out of 8 cases). Unequivocally decreased rate of *R* (2 out of 8 cases).

In 3 cases *R* is less than normal, and greater than recovery.

ii. Unequivocally increased rate of *P* in no case. Unequivocally decreased rate of *P* (4 out of 8 cases).

In 4 cases *P* is less than normal, and greater than recovery.

iii. Inhibited breathing.

iv. Diminished *V* of arm in every instance.

These experiments are not satisfactory, since their purpose was achieved in a few instances only. Once the *O* misunderstood the directions; again, the wax fell off from the fork; once the beats could not be heard; and once the *O* lost count. But it seems worth while to publish them, even if they were not successful. The failure is always indicated, so that no one can be misled by the results.

III. Attention to Tactual Stimuli.

1. Stimulus: Cold Cylinder. A brass cylinder, cooled in

ice, was drawn over the skin on the inside of the arm, just above the elbow. *O* was asked to attend to the number, character and intensity of the cold sensations.

EXP. 91. MISS JENKINS.

	1″—31.5″				1″—29.5″		
R	3.65	4.00	4.08		4.38	3.15	3.33
P	12.0	12.4	12.6		11.7	12.2	10.8
	3.91				3.62		
	12.3				11.5		

1″—65″

3.90	3.50	4.00	3.65	4.00	4.00	4.00	
11.7	11.6	12.0	12.8	12.4	11.6	11.8	

3.86
11.9

During reaction: *R* is much more inhibited at first than later. *V* rises slightly, then falls.

EXP. 92. MISS JENKINS.

	1″—36″				1″—22″	
R	4.00	4.00	3.50	4.10	4.25	4.16
P	12.0	12.6	12.1	12.6	12.5	11.6
	3.90				4.20	
	12.3				12.0	

1″—66″

4.20	4.00	4.40	4.10	4.00	4.40	4.00	
12.1	12.4	12.4	12.1	12.1	12.0	11.0	

4.21
12.0

During reaction: *R* is irregularly inhibited. *V* falls slightly.

EXP. 93. BAIRD.

	1″—45″					1″—18.5″	
R	2.75	2.95	2.55	2.80	2.50	2.40	2.60
P	12.3	12.4	11.6	11.4	12.2	10.5	10.2
	2.71					2.50	
	11.9					10.3	

1″—50.5″

2.60	2.95	2.60	2.75	2.70	2.80	
12.0	12.2	12.0	12.0	12.3	12.1	

2.76
12.1

During reaction: *R* is greatly inhibited. *V* falls.

EXP. 94. BAIRD.

	1″—50″					1″—19″	
R	3.00	3.00	2.75	2.65	2.35	2.00	2.16
P	12.2	12.5	11.3	11.4	11.3	11.1	11.0
	2.75					2.08	
	11.7					11.0	

1″—53″

2.00 2.25 2.20 2.50 2.30
10.8 10.6 10.5 11.3 11.2

2.25
10.9

During reaction: *R* is greatly inhibited. *V* falls markedly. After the reaction there is a sudden fall in *V*. This fall may be due either to a noise in the hallway outside the room in which we were working, or to an after-image of the cold spots, which B. reported. The noise seems the more likely cause, as it was very loud and sudden.

EXP. 95. GALLOWAY.

	1″—44″					1″—17″	
R	3.50	3.25	3.30	3.00	2.87	2.25	3.14
P	16.0	15.7	16.0	16.0	15.7	13.7	13.3
	3.18					2.69	
	15.8					13.5	

1″—53″

3.50 3.40 3.60 3.00 3.69
15.0 15.5 15.5 14.5 15.3

3.48
15.1

During reaction: *R* is very greatly inhibited. *V* falls precipitately.

EXP. 96. GALLOWAY.

	1″—47″					1″—17″	
R	3.30	3.40	3.60	3.60	4.00	3.00	2.28
P	15.1	16.0	16.0	15.0	15.1	13.5	13.7
	3.58					2.64	
	15.4					13.6	

1″—58″

4.30 3.70 3.50 3.50 3.50 3.50
15.6 15.6 16.3 14.2 15.0 13.7

3.66
15.4

During reaction: *R* is greatly inhibited. *V* rises slightly (probably the crest of a vaso-motor wave); then falls greatly. Vaso-motor waves are noticeable in this curve.

EXP. 97. SABINE.

	1″—42″				1″—18″	
R	3.65	3.45	3.80	3.16	3.10	3.43
P	15.0	15.0	15.0	14.0	13.3	12.1
	3.51				3.26	
	14.7				12.7	

1″—65″

3.50 3.75 3.75 3.75 3.75 3.60 2.50
—— 13.6 14.3 13.9 14.3 13.8 14.0

3.50
13.9

During reaction: *R* is somewhat inhibited. *V* falls sharply and deeply.

EXP. 98. MISS JENKINS.

	1″—42.5″				1″—16.5″		1″—64″			
R	4.00	3.90	3.50	3.88	3.61	4.20	4.00	3.70	3.70	3.70
P	13.1	12.9	13.8	13.8	11.6	12.3	12.6	12.3	12.5	12.4
		3.82				3.90			3.77	
		13.3				11.9			12.4	

During reaction: *R* is inhibited. *V* falls slightly. *O* reports that the cylinders did not seem cold.

Summary of Results.

Attention to cold spots is characterized by:

i. Unequivocally decreased rate of *R* (6 out of 8 cases). Unequivocally increased rate of *R* (1 case out of 8).

In 1 case *R* is faster than normal, but less than recovery.

ii. Unequivocally decreased rate of *P* in 6 out of 8 cases. Unequivocally increased rate of *P* in 1 case.

In 1 case *P* is the same as recovery, but less than normal.

iii. Inhibited breathing in every instance. For some *O*'s. This change is great, while for others it is less.

iv. Fall in *V* in every case. But the amount and the suddenness of the fall vary with the *O*.

2. Stimulus: von Frey's Pressure Hair. The hair was adjusted to give liminal pressures.

EXP. 99. BAIRD.

	1″—42″				1″—16″	
R	3.25	3.00	3.10	2.90	2.05	2.50
P	13.7	13.4	12.4	12.3	11.2	11.3
			3.06			2.27
			12.9			11.2

1″—64″

2.50	2.55	2.75	2.55	2.60	2.53	
12.3	11.5	11.5	11.7	11.1	11.6	
		2.47				
		11.6				

During reaction: *R* is greatly inhibited throughout, but more at the end of the reaction. *V* is unchanged during the first half of the reaction; it rises sharply during the second half.

EXP. 100. GALLOWAY.

	1″—42″				1″—15″	
R	3.75	3.40	3.80	3.33	2.10	3.10
P	15.8	16.3	16.0	16.0	13.6	13.8
			3.57			2.60
			16.0			13.7

1″—66″

3.50	3.50	3.40	3.25	3.55	3.70	3.75
13.5	14.7	15.1	15.2	15.2	15.2	15.0
		3.52				
		14.8				

During reaction: *R* is decidedly inhibited. *V* falls markedly.

EXP. 101. SABINE.

	1″—61″						1″—12″
R	3.40	2.70	2.80	2.75	3.25	3.40	3.54
P	14.0	13.6	13.9	13.4	13.4	14.3	14.0
			3.05				3.54
			13.7				14.0

1″—50″

4.00	3.55	3.45	3.70	3.25	
15.0	14.8	13.6	13.6	13.6	
		3.60			
		14.1			

During reaction: *R* is inhibited. *V* falls.

EXP. 102. MISS JENKINS.

	1″—44.5″					1″—13.5″
R	4.25	4.25	4.25	4.50	4.44	4.00
P	13.2	12.9	12.7	12.6	13.7	11.5
			4.34			4.00
			13.0			11.3

1″—65″

4.19	4.00	3.50	3.75	3.50	4.00
12.0	13.1	12.6	11.5	11.9	12.0
		3.82			
		12.2			

During reaction: *R* is moderately inhibited. *V* falls slightly.

Summary of Results.

Attention to minimal pressure is characterized by:

i. Unequivocally slower *R* (2 out of 4 cases). Unequivocally faster *R* in no case.

In 1 case *R* is less than normal, but more than recovery.

In 1 case *R* is more than normal, but less than recovery.

ii. Unequivocally slower *P* (3 out of 4 cases).

In 1 case *P* is faster than normal, and slightly less than recovery.

iii. Inhibited breathing in every case; in 2 cases more than in the others.

iv. Fall in *V* in 3 instances; in 1 case *V* rises during part of the reaction.

3. Stimulus: Glass Cylinders. A series of cylinders of different sizes were pressed upon the arm of *O*, who was asked to judge which was largest and which smallest.

EXP. 103. BAIRD.

	1″—43″				1″—9″
R	2.75	2.60	2.60	2.58	2.33
P	13.5	12.9	12.9	13.6	12.2
			2.63		2.33
			13.2		12.2

1″—70″

	2.70	2.90	2.75	2.75	2.90	2.60	2.75
	13.0	12.6	12.2	12.5	12.9	12.7	12.6

2.72
12.5

During reaction: *R* is inhibited. In this and the following experiment there are no changes in *V*. The plethysmograph functioned as a sphymograph.

EXP. 104. BAIRD.

	1″—40″				1″—13.5″
R	2.25	2.85	2.50	2.75	2.55
P	11.9	11.5	11.7	12.1	11.4
	2.60				2.55
	11.6				11.4

1″—70.5″

	2.85	2.50	2.40	3.00	2.40	2.25	2.35
	12.1	11.7	11.9	12.2	11.9	11.6	11.4

2.53
11.8

During reaction: *R* is somewhat inhibited.

EXP. 105. SABINE.

	1″—30.5″			1″—14″		1″—36″		
R	3.00	2.75	2.85	3.57	3.33	3.30	3.15	3.60
P	12.8	12.2	11.4	11.2	13.4	12.6	11.8	12.0
	2.83			3.57		3.34		
	12.1			11.2		12.4		

During reaction: *R* is inhibited, more at the beginning than at the end of the reaction. *V* falls, reaching a minimum after the second signal.

Summary of Results.

Attention to size of cylinders is characterized by:

i. Unequivocally decreased rate of *R* (1 out of 3 instances). In 1 instance *R* is less than normal, but more than recovery. In 1 instance *R* is unequivocally increased.

ii. Unequivocally decreased rate of *P* in every case.

iii. Inhibited *R* in every case.

iv. Fall in *V* in the one experiment where it is recorded.

IV. Attention to Ideas.

1. Problems in mental arithmetic. The problem was given to the *O* verbally. When he had given his answer, *E* marked the point on the drum.

EXP. 106. GALLOWAY. 25 x 33.

	1″—38″				1″—39.5″		
R	3.45	3.00	3.10	3.00	2.65	3.50	2.70
P	15.0	14.3	14.3	14.3	15.8	16.3	15.6
	3.13				2.95		
	14.5				15.9		

1″—57.5″

3.00 3.15 2.95 2.75 3.00 3.21
15.0 14.5 14.7 14.0 13.8 13.7

3.01
14.3

During reaction: *R* is slightly inhibited. *V* is scarcely changed, although it is probably slightly lowered. *O* reports that he was a little flustered by the problem. He multiplied 33 by 25, which was harder than 25 by 33. Attention seemed to be divided among a mass of things.

EXP. 107. GALLOWAY. 42 x 19.

	1″—38.5″				1″—25″		
R	3.75	3.50	3.20	3.50	2.90.	2.95	2.40
P	15.7	14.5	13.6	13.5	14.2	15.3	14.8
	3.50				2.75		
	14.3				14.8		

1″—63.5″

3.19 3.40 3.30 3.20 3.45 3.15
14.1 14.7 14.1 14.4 14.7 14.2

3.28
14.3

During reaction: *R* is inhibited. There is not much change in *V*. *O* reports a distinct feeling of holding himself in check; higher degree of concentration than before. Did not get to work quite so quickly as before; but knew just what to do when he did get to work. Some numbers were running through his mind. One of them happened to be 19.

EXP. 108. SABINE. 37 x 19.

	1″—40″				1″—16″	
R	3.25	3.00	3.00	2.95	3.10	3.16
P	15.6	14.6	14.7	13.3	13.5	13.3
	3.05				3.13	
	14.5				13.4	

1″—66″

3.25 3.00 3.15 2.85 3.00 3.25 3.33
14.0 12.9 13.0 13.0 13.0 13.5 13.0

3.12
13.2

During reaction: *R* is inhibited. The respiratory oscillation is suppressed. *V* falls. *O* reports that the numbers at first staggered him, as they were larger than he expected; although the easiness of the operation became evident when he multiplied them. He did not visualize the numbers; probably talked them.

EXP. 109. SABINE. 78 x 27.

	1″—40″					1″—63″					
R	3.75	3.65	3.40	3.45	2.66	3.80	3.60	3.00	3.00	3.60	3.27
P	——	14.5	14.3	14.4	14.3	14.1	13.7	14.3	14.2	13.9	12.3
	3.38					3.38					
	14.3					12.7					

1″—11″

3.18
12.6

3.18
12.6

During reaction: *R* is inhibited, with a couple of outbreaks of deep breathing. *V* falls, then rises to maximum; falls during recovery. *O* reports that he made several starts; got nervous and flurried. He multiplied 78 first by 7 and then by 2; but when he came to add the products together, he had forgotten them. He had to begin over again. He did this three times. The nervousness was unpleasant, but the achievement pleasant.

EXP. 110. MISS JENKINS. 16 x 17.

	1″—43″				1″—19.5″	
R	4.30	4.00	3.75	4.00	4.25	4.73
P	15.0	14.4	13.9	14.0	13.6	14.8
	4.01				4.49	
	14.3				14.2	

1″—57.5″

4.28	4.15	4.25	3.90	3.90	3.92	
14.0	13.7	13.7	13.4	13.2	12.8	
		4.06				
		13.4				

During reaction: *R* is considerably inhibited. *V* falls; then tends to rise. It falls again after the end of reaction, and remains low to the end of the experiment. *O* reports that she was dismayed by the numbers, and made two or three attempts before succeeding. She tried to visualize them, but could not do it; she then tried to say the numbers; she thinks she may have made some movements in her throat, but was not conscious of any.

EXP. 111. BAIRD. 36 x 23.

	1″—21″		1″—12⅓″	1″—58⅔″					
R	2.50	2.36	2.48	2.50	2.70	2.70	2.35	2.50	2.70
P	——	10.4	11.0	10.8	10.4	10.8	10.1	10.5	10.5
	2.43		2.48	2.57					
	10.4		11.0	10.5					

During reaction: *R* is inhibited. *V* rises rapidly at first; then falls slightly to the end of the reaction. *O* reports that the degree of attention was not high; he visualized the figures as if they were on a sheet of paper. He did not succeed in adding the two products the first time. The second time he visualized the numbers perfectly. The visualization continued into the recovery.

EXP. 112. BAIRD. 97 x 59.

	1″—43⅓″				1″—19⅓″	
R	2.60	2.65	2.65	2.20	2.83	2.90
P	11.0	11.4	10.9	11.1	12.0	13.6
	2.50				2.86	
	11.1				12.8	

1″—58⅓″

3.00	2.60	2.85	2.90	2.70	2.50
13.0	11.9	11.6	11.9	10.4	9.5
		2.76			
		11.4			

During reaction: R is inhibited. V rises. There is a slight dip in the curve after the second signal. V falls during recovery. O reports that he visualized as before; he multiplied 97 by 60, then subtracted 97. No muscular tension.

Summary of Results.

Attention to ideas (multiplication) is characterized by:

i. Unequivocally increased rate of R (3 out of 7 cases). Unequivocally decreased rate of R (2 out of 7 cases).

In 1 case R is the same as normal, but faster than recovery.

In 1 case R is faster than the normal, but less than recovery.

ii. Unequivocally increased rate of P (4 out of 7 cases).

In 3 instances P is less than normal, but faster than recovery.

iii. Inhibited R in every case.

iv. Slight changes in V; in two instances there is a rise in V (Exps. 112 and 113); in 4 cases a fall.

In 1 case V is constant.

V. Attitude Experiments.

Stimulus: König fork A_3. The following experiments were devised with a view to showing whether it is possible to obtain from the same O characteristically different reactions to the same stimulus. It seemed possible to take three different attitudes to the same stimulus. These attitudes were described to O, who was afterwards required to assume in three successive experiments: (i) an attitude of indifference to the stimulus, both as regards affection and attention; (ii) an attitude of active attention; O was asked to make a judgment as to the place of the tone in the tonal scale; (iii) an attitude of affection exclusively; O was asked to give himself up to the pleasantness or unpleasantness of the experience.

EXP. 113. BAIRD. INDIFFERENT ATTITUDE.

	1″—43″				1″—27″				
R	2.45	2.50	2.50	2.50	2.50	2.00	2.20	2.00	2.10
P	10.9	10.4	10.6	11.1	11.2	10.0	11.0	11.0	11.7
		2.48					2.20		
		10.7					11.0		

1″—55″

2.50	2.30	2.40	2.35	2.40
11.1	10.9	10.6	11.2	11.0

2.48
10.9

During reaction: R is not inhibited. V rises during reaction. O reports that he did not know what to do. He began to introspect, to see whether he was behaving indifferently. He did not attend either to the pitch of the tone or to the affection.

EXP. 114. BAIRD. ACTIVE ATTITUDE.

	1″—47″					1″—12.5″	
R	2.40	2.30	2.60	2.30	2.50	2.00	2.00
P	11.1	10.8	10.7	10.6	10.7	10.6	10.4
			2.42			2.00	
			10.8			10.5	

1″—65″

2.09	2.20	2.20	2.25	2.40	2.10	2.00
10.3	10.2	10.4	10.4	10.5	9.8	9.8

2.17
10.2

During reaction: *R* is slightly inhibited. *V* falls markedly. There is a sudden dip in the curve after the second signal. *O* reports that he was all at sea. He imaged the *c* of the great octave as a standard; he knew that the stimulus fork was above that.

EXP. 115. BAIRD. AFFECTIVE ATTITUDE.

	1″—53″					1″—16″		
R	2.20	2.60	2.35	2.65	2.30	2.00	2.00	2.50
P	10.7	10.1	10.2	11.0	10.3	10.4	9.8	10.3
			2.42				2.15	
			10.4				10.1	

1″—54″

2.20	2.20	1.16	2.20	2.25
9.9	10.3	10.0	10.2	10.2

2.19
10.1

During reaction: *R* is plainly inhibited. *V* falls slowly, then rises sharply. *O* reports that he had trouble in finding any affective tone. He compared the affective tone of the stimulus with that of the imaged *c* of the great octave. He thought that the stimulus fork would be pleasanter if lower. About one-third from the end of the reaction the pleasantness began to appeal to him.

EXP. 116. BENTLEY. INDIFFERENT ATTITUDE.

	1″—49″					1″—27″		
R	3.20	3.50	3.15	3.05	2.85	3.00	2.90	2.75
P	13.5	13.4	13.9	13.5	13.4	13.5	13.6	13.5
			3.15				2.88	
			13.5				13.5	

1″—54″

3.25	3.25	3.20	3.20	2.73
13.5	13.8	13.9	13.6	13.3

3.12
13.6

During reaction: *R* is not inhibited. *V* is slightly less. *O* reports: Passive at first; became a little excited by the thought of responsibility; this was unpleasant. After three or four seconds settled down. When tone tailed off felt some strain, but it was not at all intense. Attention was not constant.

EXP. 117. BENTLEY. ACTIVE ATTITUDE.

	1″—45″					1″—21⅓″	
R	3.10	3.55	3.25	3.50	3.40	3.30	3.27
P	14.5	14.0	14.2	14.3	14.4	14.3	14.6
	3.36					3.28	
	14.2					14.4	

1″—58⅔″

3.20	3.10	3.50	3.55	3.40	3.12	
14.5	14.7	14.0	14.0	13.6	13.0	
		3.31				
		13.9				

During reaction: *R* is perhaps slightly inhibited. *V* does not change. *O* reports that he tried to get hold of some means of placing the tone; but was kept on edge. He decided that it was *C* above middle *C*. Got to reflecting on previous tone; the association was persistent; could not relax in recovery; kept thinking of the difficulty in placing the fork; got to ruminating, and so got off from the experiment.

EXP. 118. BENTLEY. AFFECTIVE ATTITUDE.

	1″—47″					1″—15″	
R	3.40	3.50	3.80	3.20	3.28	3.40	3.00
P	——	14.7	14.2	14.5	15.0	13.9	14.0
	3.43					3.20	
	14.6					13.9	

1″—61″

3.50	3.15	3.25	3.00	3.70	3.50
14.3	14.4	14.1	14.0	13.3	13.5
		3.45			
		13.9			

During reaction: *R* is slightly inhibited. *V* is not markedly changed. *O* reports a little inclination to compel enjoyment; said to himself 'that's a mellow, pleasing tone.' Pleasantness was weak, without much glow: dull, vague. Attention was directed to the smooth, sweet side of the tone.

EXP. 119. SABINE. INDIFFERENT ATTITUDE.

	1″—31″				1″—5″
R	3.25	3.10	3.25	2.95	3.30
P	13.9	13.1	13.0	13.3	12.8
	3.16				3.30
	13.3				12.8

1″—81″

3.60	3.50	3.30	2.70	3.40	3.00	3.30	3.18	
12.7	13.3	13.1	14.0	13.6	12.7	13.3	13.2	
			3.24					
			13.2					

During reaction: *R* is inhibited and continues inhibited for ten seconds after the reaction. *V* begins to fall during the reaction, attaining a minimum after the end of the reaction. *O* reports curiosity just as the tone began to sound; wanted to know whether it was high or low. Thought it was a pleasant tone; realized that he had signalled too soon; felt foolish.

EXP. 120. SABINE. INDIFFERENT ATTITUDE. *O* was asked to make the reaction longer than in the last experiment.

	1″—51″					1″—5″
R	3.75	3.00	3.00	3.00	3.55	3.30
P	13.3	12.7	13.2	13.0	13.1	12.0
			3.26			3.30
			13.0			12.0

1″—66″

3.40	3.10	3.00	3.00	2.75	3.20	3.30
12.8	12.7	12.8	12.7	11.6	12.0	12.3

3.11
12.4

During reaction: *R* is noticeably inhibited. *V* falls sharply, attaining a minimum after the close of the reaction. *O* reports no effort to attend; tone rather pleasant; attention was divided between the idea of signalling too soon and the tone itself. Not able to keep the pleasantness out. More pleasant than before.

EXP. 121. SABINE. ACTIVE ATTITUDE.

	1″—61″						1″—9″
R	3.40	3.45	3.20	3.00	3.30	3.20	2.55
P	12.0	12.7	12.5	12.7	13.0	13.2	13.1
			3.26				2.55
			12.6				13.1

1″—55″

3.00	——	——	——	——	——	
12.0	12.1	12.6	12.3	12.0	12.2	

3.00
12.2

During reaction: one respiration is less than normal, one is more. *R* is inhibited before the reaction. *V* falls. *O* reports: Reaction very unsatisfactory because of confusion. Attention was distracted by click of signal; tried to run through the scale for ground of comparison; asked himself, "How does this experiment differ from the last one?" There was a feeling of activity; consciousness of work to do; consciousness of movements in the throat.

EXP. 122. SABINE. AFFECTIVE ATTITUDE.

	1″—53.5″						1″—10.5″
R	3.20	3.10	3.40	3.25	3.00	3.00	2.90
P	12.7	11.6	12.3	12.6	11.8	12.0	11.4
			3.12				2.90
			12.2				11.4

1″—65″

3.30	3.20	3.05	3.00	3.35	3.05	2.10
12.6	12.1	10.5	11.0	11.7	11.5	12.8

3.00
11.7

During reaction: *R* is inhibited a little. *V* falls sharply in the second half of the reaction. There is a fortuitous fall in *V* 30″ after the reaction. It coincides with the very slow pulse (10.5). *O* reports tone not nearly so pleasant as he thought it was; as he listened, the

pleasantness became flat and dull; disappointed; unpleasant at the end.

EXP. 123. GALLOWAY. INDIFFERENT ATTITUDE.

	1″—42.5″				1″—13″
R	3.50	3.50	3.25	3.40	2.73
P	16.1	14.7	15.5	15.1	15.0
	3.41				2.73
	15.3				15.0

1″—70.5″

3.33	3.25	3.25	3.50	3.75	3.75	3.57
15.6	15.7	15.0	15.1	15.1	15.0	14.8

3.48
15.2

During reaction: *R* is inhibited. *V* rises, then falls, remaining low until after the reaction. *O* reports that the normal was unpleasant on account of discomfort in the hand. The tone washed out the unpleasantness, and a feeling of tension took its place. The tension was localized in the head and neck. There was a tendency to lean forward. Attitude was not passive or indifferent.

EXP. 124. GALLOWAY. ACTIVE ATTITUDE.

	1″—51.5″					1″—18.5″	
R	3.60	3.80	3.80	3.75	3.43	2.61	3.25
P	15.7	16.5	16.1	15.6	14.6	14.2	17.0
	3.67					2.93	
	15.7					15.6	

1″—59″

3.70	3.50	3.50	3.15	3.55	3.33
16.9	16.2	15.4	15.7	14.6	15.3

3.45
15.7

During reaction: *R* is inhibited. *V* falls, reaching a minimum after the end of the reaction. *O* reports a high degree of attention from the very first; there were strain sensations from the head and neck; there was also a strain in the throat as if he were trying to sing. He thought the tone was *G* or *A* below middle *C* for the male voice.

EXP. 125. GALLOWAY. AFFECTIVE ATTITUDE.

	1″—39.5″				1″—15.5″	
R	4.00	3.50	3.80	3.89	3.39	3.60
P	16.0	15.0	15.3	15.4	14.7	15.0
	3.79				3.48	
	15.4				14.8	

1″—74″

4.25	3.60	3.80	3.90	3.70	3.80	3.75
16.0	15.5	15.8	16.2	17.2	15.4	13.7

3.82
15.5

During reaction: *R* is inhibited. *V* falls moderately, not nearly so much as with active attention. *O* reports that he became expectant just before the reaction. The reaction began unpleasantly, because

the tone was not sounded intensively enough; it was hard to grasp. The affective tone then became slightly pleasant; then unpleasant, because the tone seemed rough. As a whole the experience verged on unpleasantness.

Summary of Results.

I. INDIFFERENT ATTITUDE.

i. *R* is unequivocally increased in 2 cases (same *O*).
R is unequivocally decreased in 3 cases.

ii. *P* is unequivocally increased in 1 case.
P is unequivocally decreased in 3 cases.
P is same as normal, but less than recovery, in 1 case.

iii. *R* is not inhibited in 2 cases; in 3 cases it is inhibited.

iv. *V* rises in 1 case; rises and falls in another; in the other three cases, falls either slightly or much.

II. ACTIVE ATTITUDE.

i. *R* is unequivocally slowed in every case.

ii. *P* is unequivocally quickened in 2 cases.
P is unequivocally slowed in 1 case.
P is greater than recovery, and less than normal, in 1 case.

iii. *R* is inhibited slightly in 2 cases, in 1 case irregularly inhibited; in the fourth case more greatly inhibited.

iv. *V* falls in 3 cases; in one case it is unchanged.

III. AFFECTIVE ATTITUDE.

i. *R* is unequivocally slowed in every case.

ii. *P* is unequivocally slowed in 2 cases.
P is equal to recovery, but less than normal, in 2 cases.

iii. *R* is inhibited in every case, but only slightly in 2 cases.

iv. *V* in one case falls and rises; in one case remains unchanged and then rises; in 1 case shows no change; in the last instance falls.

Summary of the same Results, according to Observers.

I. INDIFFERENT ATTITUDE.

BAIRD	R —	P +	R inhibited	V +
BENTLEY	R —	P=K	R inhibited	V — (very slightly)
SABINE (i)	R +	P —	R inhibited	V —
SABINE (ii)	R +	P —	R inhibited	V —
GALLOWAY	R —	P —	R inhibited	V + —

II. ACTIVE ATTITUDE.

BAIRD	R —	P —	R inhibited	V —
BENTLEY	R —	P +	R inhibited slightly	V = K
SABINE	R —	P +	R irregularly inhib.	V —
GALLOWAY	R —	P +	R inhibited	V —

III. AFFECTIVE ATTITUDE.

BAIRD	R —	P —	R inhibited	V —

BENTLEY	R —	P —	R inhibited slightly V = K
SABINE	R —	P —	R inhibited slightly V —
GALLOWAY	R —	P —	R inhibited V —

VI. Miscellaneous Experiments.

Two sorts of experiments fall under this head: (i) aborted experiments, in which, for any reason, the required conditions were not fulfilled; and (ii) three experiments in which it was attempted to secure a state of active attention without resorting to sensory stimulation. Expectation on the part of *O* was the chief cause of the first class of experiments. If, during or about the end of the normal period of quiescence, *E* saw the *V*-curve suddenly fall, it was usually safe to conclude that the *O* was strongly expecting the stimulus. Only one such experiment occurred in the visual, while there were several in the auditory experiments.

EXP. 126. MISS ANDRUS. Stimulus should have been a Masson disc.

1″—97″

R	3.00	2.90	3.00	3.00	2.95	3.00	2.75	2.60	3.10	3.42
P	12.0	11.5	11.7	11.2	11.5	11.0	11.2	11.0	11.5	11.4

2.97
11.4

1″—30″

2.25 2.85 2.60 2.70
10.5 11.0 11.5 11.0
2.60
11.0

Up to 80 seconds the rate of *R* is fairly constant. After that point the rate is noticeably increased. There is a less marked increase in the rate of *P*. The fall in *V* began earlier than the changes in the rate of *R* and *P*. At the 97th second, *E* said "there will be no stimulus this time." After that the rates of both *R* and *P* decrease. *V* begins to rise. *O* reports a definite expectation of the experiment some time before *E* said that there would be no experiment.

EXP. 127. GALLOWAY. Stimulus should have been watch-tick coming in and receding.

1″—87″

R	3.25	3.05	2.75	2.70	2.95	2.75	2.40	2.60	2.85
P	15.5	16.3	16.7	16.4	16.3	16.7	15.3	15.2	15.2

2.81
15.9

1″—42″

2.90 2.90 2.75 3.12
— 15.1 16.1 15.7
2.91
15.6

At the 40-50 second *E* saw the volume fall spontaneously, with inhibition of *R*. He suspected expectation and therefore did not give the stimulus. At the 87th second, *E* said 'no experiment;' *V* then

rises, and the rates of R and D tend to increase. The expectation seems to be characterized by a slowing of both P and R.

EXP. 128. GALLOWAY. Stimulus should have been the counting of beats.

1″—95″

R	3.75	3.25	2.95	3.45	3.55	3.25	3.75	3.20
P	13.8	14.4	—	14.4	14.1	14.5	14.2	14.6

3.39
14.2

1″—37″

3.50	3.05	3.00	2.93
14.6	15.0	14.0	13.5

3.12
14.2

At the 95th second E saw V fall and suspected expectation. He said 'no experiment.' After this, rates of both R and P tend to decrease, and V rises. O reports that he was perplexed by thinking how he should describe the beating tones.

EXP. 129. GALLOWAY.

Stimulus should have been the counting of beats. E gave the signal 'now;' but delayed some seconds to actuate the forks. As E thought too much time had been lost, he did not sound the forks at all, but after 21 seconds said 'no experiment.'

1″—53″

R	3.25	3.20	3.10	3.20	3.26
P	16.1	15.6	15.3	15.1	15.0

3.20
15.4

1″—21″

3.30	3.54	
15.5	15.4	

3.42
15.4

1″—50″

3.50	3.40	3.20	3.10	3.25
15.4	14.7	15.0	15.8	14.6

3.29
15.1

For the reaction, the rate of R is unequivocally quickened. The rate of P is the same as the normal but greater than the recovery. This means an increased rate of P, because the initial normal rate of P is unusually high. R is inhibited a little; more at the end than at the beginning. V falls almost immediately, and begins to rise before the end of the reaction.

EXP. 130. GALLOWAY.

Stimulus should have been the counting of beats. The normal was so irregular that no stimulus was given. After 60 seconds, E said 'no experiment.'

1″—61″

R	3.80	3.40	3.40	3.50	3.00	3.13
P	16.0	15.0	—	14.2	14.0	15.2

3.37
14.8

1″—60″

4.05	3.50	3.00	3.45	3.30	3.00
15.0	15.2	15.0	15.0	14.7	—

3.38
14.9

In each half of this experiment, the rates of both *R* and *P* begin rather high and fall off during the rest of the experiment. *O* reports that his shoe pinched; that there was a feeling of relaxation after the signal 'no experiment.'

EXP. 131. BAIRD.

Stimulus was the slow tick of a metronome—39 per minute.

	1″—48⅓″					1″—30⅔″		
R	2.25	2.55	2.45	2.10	2.40	2.12	2.40	2.20
P	9.9	10.6	10.7	10.2	11.7	10.1	10.6	10.3
		2.35					2.24	
		10.6					10.3	

1″—47″

1.80	1.70	2.00	2.05	2.30
10.0	9.7	9.8	9.8	10.0

1.97
9.8

During reaction: *R* is considerably inhibited, more in the middle of the reaction than elsewhere. *V* falls sharply, reaching a low level. *O* reports a feeling of strain which he could not localize: it seemed as if the clicks were never going to come.

EXP. 132. SABINE.

Stimulus should have been a cold cylinder. *E*, seeing the volume fall and suspecting expectation, said 'no experiment.'

1″—50.5″

R	3.50	3.00	3.50	3.75	3.33
P	15.5	15.1	13.6	13.4	13.5

3.40
14.0

1″—70.5″

3.80	3.65	3.35	3.80	3.55	3.50	3.00
12.9	13.0	13.3	14.0	13.5	13.0	13.0

3.52
13.2

O reports: nothing prominent in consciousness; rather surprised when *E* said 'no experiment;' thought something had gone wrong. There is second spontaneous fall in *V* 30 seconds before the end of the curve.

E was probably wrong in attributing the first fall in *V* to expectation, inasmuch as *O*'s introspection did not bear him out.

The three following experiments were devised with a view to securing a high degree of attention without direct stimulation of the sense organs. It seemed possible to attain a moderately high degree of attention by letting ideas, as in a revery, take their own course through consciousness. The experiment began with normal indifference on the part of *O*. As soon as he became interested in his ideas, he signalled; when his interest was interrupted, he signalled again; so that the period of the greatest clearness of ideas was marked off from the normal and recovery periods.

EXP. 133. BENTLEY.

1″—39″

R	2.80	3.20	3.05	3.44
P	14.0	13.6	13.6	13.5

3.12
13.7

1″—86″

2.95	2.90	3.10	3.05	3.05	3.00	3.05	3.30	3.00	
13.5	13.5	13.6	13.3	13.4	13.4	12.9	12.6	12.6	

3.04
13.2

During reaction: *R* is, if anything, a little higher; but the difference is very slight. *V* rises very gradually throughout the curve. *O* reports that during normal he was thinking 'Now I must get myself into this state;' there was more tension, more excitement than in reaction. During reaction attention went up and down; there was a high degree of attention because the ideas were clear; but attention was not constant. Also there was a conscientious pulling together now and then, along with a feeling of responsibility. There were excitement and unpleasantness with the sense of responsibility. Good bodily tone; quite relaxed.

EXP. 134. BENTLEY.

1″—25″

R	2.80	3.10	3.40
P	13.4	13.5	12.8

3.10
13.2

1″—35″

2.50	2.75	2.75	2.70	
13.4	13.4	12.6	13.4	

2.67
13.2

1″—3″

4.00	
12.6	

4.00
12.6

1″—47″

3.00	3.25	2.80	2.80	2.85	
13.2	13.5	13.4	13.5	13.5	

3.11
13.4

1″—10″

3.00
13.5

3.00
13.5

During the first reaction, *V* is a little higher; there is a slight drop in the curve at the beginning of the second reaction. *O* reports that during normal he is getting adapted to the situation. During the first reaction, attention was flighty and there was some excitement. Unpleasantness because attention was spasmodic and fitful. A little bit disappointed with the state of things. During the second reaction, he picked his way through ideas. Attention if anything was unpleasant

EXP. 135. BENTLEY.

1″—16″

R	2.90	3.33
P	13.5	12.6

3.11
13.0

1″—110″

R	3.10	3.10	3.60	3.00	3.35	3.40	3.20	3.10	3.05	3.25	3.10
P	13.6	13.5	13.6	13.0	13.0	13.0	13.8	13.5	13.5	13.7	13.0

3.20
13.3

During reaction there is no noticeable change in the depth of *R*. *V* tends to rise gradually. *O* reports: normal free from affection; set-

tling down. Reaction. Attention to auditory ideas and visual perceptions. *O* made a false signal, which made him uncomfortable, because he thought it might confuse *E*. There was a strain of unpleasantness all through. An occasional idea with fleeting unpleasantness. Moderate degree of attention; not sharp.

Summary of Results of Last Three Experiments.

i. There is no consistent change in rates of *P* and *R*.

ii. Slightly increased *V* and slightly deeper breathing occur in revery.

iii. Probably sensory stimulation causes fall in *V*.

iv. Apparently centrally excited feelings have very slight effect on *P*, *R* and *V*.

EXP. 136. SABINE. *E* traced with a pencil the letters *H C S* on *O*'s cheek. *O* attempted to decipher them.

	1″—42″				1″—24″		
R	4.00	3.10	3.10	3.33	3.50	3.25	3.10
P	12.8	11.5	12.0	12.5	11.2	10.6	11.2
		3.38				3.28	
		12.2				11.0	

1″—58″

3.90	3.50	3.30	2.80	2.60	2.70
11.4	11.6	11.1	11.4	12.4	12.2

3.13
11.6

During reaction: *R* is considerably inhibited. *V* falls markedly, reaching a minimum after reaction.

C. GENERAL SURVEY OF RESULTS AND DISCUSSION.

I. Changes of Rates of P and R.

1. In order to put the main results of the study in form for discussion, the experimental data may now be tabulated. Since there were many equivocal results, either some rule must be adopted for their interpretation, or they must be excluded from the Table. But since these results may be instructive in themselves, it was not deemed proper to exclude them. There are six sorts of equivocal cases:

1. Reaction rates of *P* and *R* faster than normal and slower than recovery.

2. Reaction rates of *P* and *R* slower than normal and faster than recovery.

3. Reaction rates of *P* and *R* same as normal and faster than recovery.

4. Reaction rates of *P* and *R* same as normal and slower than recovery.

5. Reaction rates of *P* and *R* same as recovery and faster than normal.

6. Reaction rates of *P* and *R* same as recovery and slower than normal.

The following disposition was made of these cases. 1, 3, and 5 were counted with the unequivocal increases in the rate of *P* and *R;* cases 2, 4, 6, were counted with the unequivocal decreases in rate. Since there were four physiological symptoms determined, there will be four main rubrics in the Table: rate of pulse; rate of respiration; depth of respiration; and volume. Under each of these rubrics there will be three sub-heads, since each physiological symptom may vary in any one of three ways, *viz.*, *P* and *R*, with respect to rate, may increase, decrease, or remain unchanged; *R*, with respect to height, may increase, decrease, or remain unchanged; *V* may rise, fall, or remain unchanged. The experiments are grouped according to the sense department to which the stimulus appealed. Thus, there is a visual, auditory, and tactual group. The number of experiments is also given (Table I, p. 466).

The Table shows characteristic differences of reaction for the different kinds of experiments. For the visual group the rate of *R* is very greatly increased. The rate of *P*, on the other hand, does not change consistently. In approximately half the cases, the rate of *P* is faster, and in the other half, the rate is slower. The auditory group shows another correlation. The rate of *P* in these experiments is as decidedly decreased as the rate of *R* was increased in the visual group. The rate of *R*, on the other hand, in the auditory group is almost as equivocal as was the rate of *P* in the visual group. The tactual group varies in still another way. Both *R* and *P* are very decidedly slowed. The changes for multiplication resemble those for visual stimuli. This may be due to the fact that the *O*'s as a rule visualized the figures. The other physiological symptoms seem to show no differentiation according to stimulus. The overwhelming result for all experiments is inhibited breathing and diminution of the *V* of the arm. In order that the characteristic changes in rate of *P* and *R* may not be attributed to the manner of distribution of the equivocal results, the unequivocal results are given alone, in a similar Table (Table II, p. 467).

The Table of unequivocal results brings out the same fact as the Table of both equivocal and unequivocal results. In the visual experiments, the rate of *R* is always faster, while the rate of *P*, with the exception of the experiment with the Masson disc, is about evenly divided between faster and slower. In the second group, the rate of *P* is very decidedly slower, while the rate of *R* is in some cases faster and in others slower. The slowing of both *P* and *R*, in the third group, is even more pronounced than in the Table of mixed equivocal and unequivocal results.

TABLE I.

Kind of Experiment	PULSE			RESPIRATION						VOLUME			Number of Experiments
				RATE			DEPTH						
	Faster	Slower	Unchanged	Faster	Slower	Unchanged	Deeper	Shallower	Unchanged	Fall	Rise	Unchanged	
Masson disc	9	4	1	13	1			14		13	1		14
After-image	5	7		9	3		1	11		11	1		12
Radii of Circle	6	4		9	1		2	8		7		3	10
Radii with Intrinsic Interest	2	5		6	1			7		7			7
After-image with Intr. Interest	3	3	1	6	1			6	1	3		4	7
Natural Interest	2	4		5	1			6		2		4	6
Difference tone	3	5		4	4			8		5	1	2	8
Watch in-out-in	2	5		5	2			7		6	1		7
Watch out-in-out	0	5		1	4			5		4	1		5
End of Tone	4	5	1	3	7			10		9	1		10
Counting Beats	0	8		3	5			8		8			8
Cold Cylinder	1	7		2	6			8		8			8
Pressure Hair	1	3		1	3			4		3	1		4
Comparing Size of Cylinders	0	3		1	2			3		1		2	3
Multiplication	4	3		5	2			7		4	2	1	7

NOTE. In fifteen experiments, volume changes were not recorded because the plethysmograph functioned as a sphygmograph. These experiments were 19, 30, 37, 38, 39, 47, 48, 49, 50, 51, 52, 53, 54, 103, 104. The cause of this fact was a leak in the air system.

TABLE II.

Kind of Experiment	PULSE			RESPIRATION			No. of Experiments
	Faster	Slower	Unchanged	Faster	Slower	Unchanged	
Masson disc	8	2		10			14
After-image	3	2		8			12
Radii of Circle	2	3		8			10
Radii (Intrinsic Int.)	2	3		6	1		7
After-image (Intrinsic Int.)	1	1		4			7
Natural Interest	1	1		4			6
Difference tone	3	1		4	3		8
Watch out-in-out	2	4		5	1		7
Watch in-out-in	0	4		1	3		5
End of tone	1	5		2	7		10
Counting beats	0	4		3	2		8
Cold Cylinders	1	6		1	6		8
Pressure Hair	0	3		0	2		4
Size of Cylinder	0	3		1	1		3
Multiplication	4	0		3	2		7

The experimental results of this study force, then, the following conclusion upon us. Either we must say that active attention is different in kind according as the object of attention is a visual, auditory, or tactual sensation, in just the same way as we speak of visual and auditory types of memory; or we must say that the changes in the rates of P and R are not due to attention at all, but are due to the psychophysical process of the sensation; or, as a third possibility, to the co-operative influence of both attention and the psychophysical process of sensation. The first possibility may be correct, although at present there is no theory of attention which discusses such a view.[1] As for the third possibility, the method of expression has assumed that the purely reflex effect of the stimulus, if any at all, is very slight, compared with the expression of the mental process. There is, however, positive evidence in favor of the second possibility. Mentz[2] says, "With tones and clangs, as well as with noises, in consequence of increasing intensity, there appears an increasing lengthening of pulse which, nevertheless, with high intensities is again decreased on account of unavoidable unpleasantness, and indeed even passes over to a shortening. The cause of the original

[1] *Cf.*, however, Art. Attention in Baldwin's Dict., I, 86; also Titchener, *Am. Jour. of Psych.*, XVI, 214.

[2] Phil. Stud., XI, 95.

Experiments were 19, 30, 37, 38, 39, 47, 48, 49, 50, 51, 52, 53, 54, 103, 104. The cause of this fact was a leak in the air system. These

lengthening is probably a direct effect of the psychophysical process of the sensation, since this process physiologically spreads out more widely in the organism with greater intensities, and thus draws into sympathetic action not only the involuntary and voluntary muscles, but also the vessels and, with greater intensities the heart." Mentz gives results from Mosso's work which show the same effect of auditory stimuli. Lehmann[1] says with regard to the physiological effect of cold: "It follows that cold, in every case, produces a lengthening of pulse, except where it is painful; then it, like every other unpleasant stimulus, has as a consequence shortening of pulse." Warmth has the opposite physiological effect. Finally, Kelchner[2] finds that "with pleasantness the pulse is accelerated, if the pleasantness is set up by taste stimuli; the pulse is slowed if tones and colors serve as stimuli." In the case of unpleasantness, there was no differentiation of results according to stimulus. Changes in respiration were also independent of stimulus. While it is true that there is not a uniformity among these purely physiological effects, as one might expect if the reaction were reflex, it is quite possible that different intensities as well as different qualities of stimulus give different physiological reactions. The Ritter-Valli phenomenon is a case in point. With a certain very low intensity of stimulus, the extensor muscles of the claw of the crayfish are stimulated; with higher intensities, the flexors.[3] Something of this sort may hold for smooth muscle. Again, it is known that exposure to low temperature depresses the vaso-constrictor nerves more than the vaso-dilator nerves. Also, if a mixed nerve is stimulated with rapid induction shocks, the effect is vaso-constriction; if with slow induction shocks, vaso-dilatation. Assuming the results to be purely reflex, there seems to be sufficient evidence, on physiological grounds alone, to account for divergences.

It will probably be urged against this view that it takes account of only a few negative cases, while it neglects a well confirmed correlation, that between changes in rate of *P* and *R* and active attention. We propose, therefore, to examine the experimental evidence for this correlation. The results may be thrown into a Table (Table III) which will include the name of the investigator and the date of his work; the stimulus to attention and the resultant changes in rates of *P* and *R*, together with the number of experiments and the number of *O*'s, so far as these data are obtainable. The plus and minus

[1] Die körp. Aeusser. psych. Zustände, 114.
[2] Arch. f. g. Psych., vol. V, 39.
[3] *V.* Schäfer's Physiol., II, 480, for a description of this and similar phenomena.

TABLE III.

Investigator		Stimulus to Active Attention	Pulse			Respiration			No. of Exprs	No. of O's
			Faster	Slower	Unchanged	Faster	Slower	Unchanged		
Mosso	1879 1881		+			No correlation				
Von Thanoffer	1879	Intellectual work (arithmetic)	+							
Gley	1881	Intellectual work (reading)	+							
Delabarre	1892	(i) Muscular effort: single pressure of dynam.; sustained pressure; pressed thumbs together; moved arms up and down.				+			not given	1
						+				1
		(ii) Auditory: metronome. For D.				+			"	1
		For R. when normal rate did not exceed 25				+			"	1
		For P. when normal rate was 26				—			"	1
		For P. when normal rate was 15.				+			"	1
		For Rn.				+ very slight			"	1
		(iii) Visual—Looking at objects. For D.				+			"	1
		Rivalry of Perception. Observer not given.				+			"	
		(iv) Tactual. Designs traced on skin For D.				+			"	1
		For R and Rn.				changes very slight			"	2
		(v) Counting objects. For D.				+			"	1
		(vi) Reading mentally. " "				+			"	1
		(vii) Writing. " "				+			"	1
		(viii) Internal recitation				Sometimes faster			"	
		" music if music is sad				—			"	
		if music is gay				Not so slow			"	
		(ix) Arithmetic. For D.				+			"	1
		For Rn.				+ a little			"	1
		For R.				Little changed			"	1
		(x) Recollection of series of letters. For D.				+			"	1
Mentz	1895	Metronome rates	+			+			20	3
		Comparison of two intervals filled with metronome beats	+						1	1
		Comparison of two pitches given by Appunn tonometer	+			1	2	1	4	1
		Multiplication	+			+			2	1
		Descartes' theory (i) without effort reproduced	+			+			2	1
		(ii) Exactly reproduced	+			+			1	1
		Watch at liminal distances	+			4	4		8	1
		Different degrees of attention to metronome beats	10	6		8	8		16	2
Binet and Courtier	1895	Arithmetical operations	+	- one O					not given	7
	1896	(i) Short intense work. Mental arithmetic	+			+			9	6
		(ii) Prolonged intellectual work		—					2	2
Shields	1895	"Mental reaction"	+							12
McDougall	1896	(i) Watch liminal	+			+			not	7
		(ii) Tactual—Design traced on skin		—			—		given	5
		(iii) Recall of past events—Lecture, instruments, events in a day	±			+			"	5
		(iv) Arithmetical operations	±			+			"	5
Angell and Thompson	1899	Addition, memorizing nonsense syllables, multiplication	No correlation			No correlation			"	2
Lehmann	1899	Punktezahlen, multiplication, reading over nonsense sylables, recollection of melody	+			Irregular. Toward end of reaction faster.			"	not given
Winkler	1898	Concentration of attention.	+			+				
Hirsch	1899	Mental arithmetic	+							
Zoneff and Meumann	1901	(i) Optical	3	16		14	5		19	5
		(ii) Acoustic		7		6	1		7	3
		(iii) Tactual		5		4	1		5	3
		(iv) Attention to ideas. Multiplication	3	7		7	3		10	4
Bonser	1903	Multiplication, memorizing, reading difficult books	During preliminary vaso-dilatation + Rate is not given for rest of reaction							12
Gley	1903	Questions involving natural interests	±			+				

signs mean acceleration and retardation of P and R. $\pm$ means acceleration followed by retardation.

TABLE III.

With regard to the rate of P, the Table shows uniformity, with three exceptions: (i) the slowing of P with tactual stimuli, in McDougall's experiments; (ii) the slowing of P in all of Zoneff and Meumann's experiments; (iii) the denial of correlation by Angell and Thompson. There is also the fact, first pointed out by McDougall, that frequently the rate of P first increases, then decreases even below the norm. Binet and Courtier confirm this result, as does Gley in his later work. Unfortunately, most investigators have given only the main results of their work. The total number of experiments, and especially the number and kind of discrepant results, are almost always lacking. The rate of R is uniformly increased, with three exceptions: (i) Mosso found no correlation; (ii) McDougall found slowing of R with tactual stimuli; (iii) Angell and Thompson deny correlation. And Lehmann found increase in rate of R only under certain conditions. On the other hand, Delabarre, Mentz, McDougall, Binet and Courtier, and Zoneff and Meumann find, on the whole, an increased rate of R, although had Delabarre taken more observations from other O's than 'D,' his results would, apparently, have been different. A fact which may possibly help to explain the universal quickening of R is the almost universal use of visual stimuli, such as reading, counting dots, arithmetical operations, which were probably performed visually, and reading-over nonsense syllables. Of course, against this suggestion, it can be shown that Mentz used auditory stimuli mainly and nevertheless found quickened rate of R, although there were many cases of retarded R, and that McDougall did not use visual stimuli at all. But on the other hand, Zoneff and Meumann make 19 experiments with optical stimuli against 12 with acoustic and tactual together. A reasonably long series of experiments with auditory and tactual stimuli has never been made. Whatever may be the cause, the present status of the matter is this: for pulse, (i) two contradictory correlations, (ii) a denial of correlation; for respiration, (i) a uniform correlation, (ii) a partial contradictory correlation, and (iii) two denials of correlation.

We think, therefore, that the appeal to the facts does not sustain the objection that we have based our thesis on a few irregularities in the face of a well established correlation. The well established correlation does not exist. And furthermore, what correlation there is depends on a narrow range of ex-

periments, in which discrepancies have been largely neglected, carried out on a small number of *O*'s.

Again, it may be objected that the discrepancies in our results can be explained by differences in the state of attention itself. It may be said that attention to minimal pressures and cold spots is not of the same sort as attention to a Masson disc. In the one case attention is powerfully attracted; in the other it has to be sustained by effort. In short, the tactual and part of the auditory experiments are expressions of passive attention, while the visual experiments are expressions of active attention. This theory of the results would bring about a happy compromise. According to it, the results would confirm Mentz' thesis that active attention accelerates *P* and *R*, while passive attention retards them. And so the question of the validity of the method would not be raised at all. This view has a certain amount of plausibility, but it leaves out of account several considerations. (i) The known physiological fact that stimulation of a centripetal nerve or of a sense organ does produce reflex acceleration or slowing of the heart. There is no uniform result (such is the impression one gets from Tigerstedt's review[1] of the literature) from this sort of stimulation; but the important point for this argument is, that the heart does respond reflexly. (ii) The purely physiological effects of certain stimuli, demonstrated by Mentz, Lehmann and Kelchner. (iii) The difficulty of discovering a reason for calling attention to tactual and auditory stimuli passive, and attention to visual stimuli active. Attention to a liminal pressure or auditory stimulus is, surely, just as active as attention to a liminal visual stimulus.

A third objection may be made: that we use the method of expression to obtain results, while we deny that the method is expressive. This objection is merely verbal. The method, apparently, is not expressive in that it consistently characterizes a total state which we call active attention; but it is expressive in the sense that it responds to certain physiological processes which may vary while the total state of attention, as regards degree and kind, remains the same. That is, the method is expressive for certain inessential features of the attentive experience; but it is not expressive for the state as a whole, which is itself the object of investigation.

The argument of this paper, up to this point, may now be summarized. The method of expression has failed in the domain of feelings. Two possible reasons were suggested: (i) complications with other mental processes, and (ii) the psychophysical processes of the sensation. The results of this

[1] Phys. des Kreislaufes, pp. 282-289, 1893.

study point definitely to the second factor, unless one is willing to speak of visual, auditory and tactual attentions, as we speak of visual or auditory memories. Three objections were brought against this view. (1) It is based on a few discrepancies from a well established correlation. Reply: the correlation is not well established. (2) The results are the expressions of active and passive attention. Reply: liminal stimuli all require active attention, yet the expression is different. (3) We deny that the method of expression is expressive, and yet make use of its results. Reply: this objection is merely verbal.

II. The Significance of the Changes in Volume. So far, we have considered only two symptoms of the expressive method, *viz.*, changes in rate of *P* and *R*. It may now be asked whether the changes in *V* and depth of breathing are expressive or merely reflex. In these experiments, as Table I. shows, *V* and depth of *R* changed consistently with active attention. Wherever there was a state of active attention, there were always a fall in *V* and inhibited breathing. These two symptoms, therefore, would seem to be the characteristics of active attention. But there is, at least, positive evidence against the *V* change. Just as the changes in rates of *P* and *R* brought suspicion on themselves by a too pliant response to experimental conditions, so the *V* change brings suspicion on itself by a too indiscriminate response to experimental conditions. The all but invariable reaction in our own experiments was a fall in *V*. The all but invariable reaction in the whole literature of the expressive method, whether applied to the feelings or to attention, is a fall in *V*. We conclude, therefore, that *every sensory stimulus tends to produce a fall in volume of the arm*. The evidence for this thesis is as follows. (i) In exps. 133, 134, 135 of this paper, in which there was a state of active attention without sensory stimulation, *V* showed no tendency to fall. (ii) The greatest and most sudden changes in *V* come at the very beginning of the reaction, during or immediately after the period of stimulation, although it is improbable that the highest degree of attention has been attained at that point. (iii) The fact, already mentioned, that fall in *V* independent of mental conditions has been the almost universal reaction in all experiments with the plethysmograph. A detailed review of the results of the method of expression as regards *V* will, we think, bear out this statement. The results may be tabulated. The name of the author, the date of his work, together with the kind of stimulus, affective or attentive, and the change in volume expressed by a plus or minus sign to indicate a rise or fall respectively are given.

The Table shows a uniform decrease in *V* for all mental con-

TABLE IV.

Investigation	Stimulus	Volume
Mosso 1879, 1881	Every psychic activity	—
Féré 1887	Pleasant	+
	Unpleasant	—
Lehmann 1892	Pleasant	+
	Unpleasant	—
Hallion and Comte 1894	Tactual, auditory pain	—
Shields 1895	Olfactory sensations and mental work	—
Binet and Henri 1895	Cold, tactual sensations	—
	Pleasant and unpleasant emotions	—
	Intellectual work	—
Binet and Courtier 1896	Pleasant and unpleasant emotions	—
Angell and McLennan 1896	Active attention	— 75%
		+ 25%
	Agreeable	+ ? %
	Disagreeable	— 90%
McDougall 1896	Watch tick, mental arith., recall of past events	—
Angell and Thompson 1899	Emotions, intellectual operations, sensations	—
Lehmann 1899	Voluntary attention	—
	Involuntary attention (fright)	—
	Spannung	—
	Unpleasantness	—
	Pleasantness	+
Gent 1903	Strain	—
	Relaxation	+
	Pleasantness	+
	Depression	—
Gley 1903	Mental arithmetic	—
Bonser 1903	Mental arithmetic	—

ditions, with the exception of Féré's, Lehmann's and Gent's work. Angell and McLennan found a rise in *V* with agreeable stimuli in an unspecified percentage of their experiments. But since they do not publish curves, or state their results precisely, one is justified in not taking their results into account.

We propose, now, to examine, so far as this is possible from their published results, the evidence for the rises in volume asserted by Féré, Lehmann and Gent. Féré, *Sensation et Mouvement*, finds that sensory stimuli when tested with a dynamometer fall into a dynamogenic series. In chapter XVII, he finds that taste, smell, auditory and visual stimuli, when tested with the plethysmograph, also arrange themselves according to the degree of their effects. Féré does not say, as he does in the case of the dynamometry experiments, that the change in *V* is correlated with the affective tone of the stimulus. On the contrary, at least in the case of diffusible excitants as alcohol and ether, he suggests that the type of reaction is due to intensity of stimulus. "Une excitation faible produit la dilatation; une peu plus forte, la dilatation suivie de rétraction proportionelle; une excitation très forte, une rétraction immédiate" (p. 108). On p. 113 Féré says, "Toutes les émotions dépressives déterminent une diminution de volume dans les membres; toutes les émotions excitantes ou agréables déterminent un effet inverse." We have failed to discover any curves in either edition of *Sensation et Mouvement* which exemplify this conclusion.

Lehmann, *Die Hauptgesetze* etc., publishes nineteen curves, of which thirteen are reactions to simple pleasant or unpleasant stimuli. The curves with the initial of the observer and stimulus are as follows:

I A.	M	Sugar solution.
I B.	C	Eau de Cologne.
I C.	M	Saccharin.
I D.	D	10% quinine sulphate.
II A.	D	Lukewarm water with a few drops of tartaric acid.
II B.	D	Hand in 50° water. Unpleas.
II C.	M	Pin stuck in nates.
II D.	M	Carbon bisulphid. Told it was pleasant.
II E.	O	Arm in water 43°. Decidedly pleasant.
III A.	D	Tobacco cigarette. Pleasant.
III B.	O	" " Unpleasant.
III C.	M	Wall paper. Æsthetic pleasure.
IV A.	D	Tuning fork sympathetically actuated. Intellectual pleasure.
IV B.	M	Fright.
IV C.	E	Fright.
IV D.	D	Depression.
V A.	E	Fear.
V B.	E	Fright.
V C.	M	Anger.

These experiments, where possible, were carried out on two other observers. In all there must have been fifty-seven curves, of which thirty-nine were simple feeling curves. But we are here concerned only with the curves of pleasantness. These curves are I A, I B, I C, II E, III A, III C, IV A. If these experiments were repeated on two other observers, there must have been twenty-one curves to generalize from. These curves must now be examined with regard to the amount and character of the rise in *V* and its coincidence with the period of stimulation.

I A. The *V* before stimulation is very low. Just after stimulation there is a sudden though very slight rise in *V*. The *V* remains almost level for thirty seconds, although there is a slight gradual increase, which reaches a maximum twenty-eight seconds after the stimulus was applied. The absolute and relative change in *V* is so slight and comes so long after the stimulus that it seems very doubtful whether any positive conclusion can be drawn from it.

I B. There is undoubtedly a rise in *V* coincident with the period of stimulation. Although it should be pointed out that the *V* was low when the stimulus was applied.

I C. This curve is very much like I A. The normal is very low and the reaction is very long delayed (due to the dissolving of the saccharin, Lehmann says) and very slight when it comes. About twenty-two seconds after the substance is tasted and forty seconds after it is administered, there is a slight rise in *V*.

II E affords a good illustration of the freedom of interpretation that is possible in work of this kind. Lehmann says that for ten seconds after stimulation the *V* diminished, then increased until it exceeded the normal level. So it does; but not until thirty seconds after stimulation. Without some good introspective reason, it seems inadmissible to call a subsequent rise in *V*, after an initial fall, the expression of an affective process.

III A. Lehmann calls this curve an *ausgeprägte Lustcurve*. The fact is this. The *V* for nearly thirty seconds after stimulation is less than that at the time of stimulation. A decided rise in *V* does not occur until forty-five seconds after stimulation. Furthermore, the rise in *V* does not occur so soon nor is it so marked when it occurs, as is the rise in *V* in III B, the unpleasant tobacco curve. In III B a very decided rise in *V* occurs a few seconds after the stimulus is applied. There is a low *V* for twenty seconds, with a very decided increase before the period of stimulation is over. This curve is very much like II E in its general type. The stimulus for II E was *entschieden lusterregend*. Lehmann finds a physiological reason for the fall in *V* in II E, although, apparently, he is willing to attribute the fall in volume in III B to the unpleasantness of the tobacco. If II E is called a curve of pleasantness, we see no reason why III B should not be so called.

III C is a curve of æsthetic pleasantness. The *V* falls for about ten seconds, then slowly attains and gradually surpasses the level before stimulation, and sinks slightly below the normal level before the stimulus is removed. Here, again, the curve has the same general aspect as II E, III A and III B, namely, a low level for several seconds after stimulation, with a gradual return to the normal level or above it. But there is a positive rise in this curve, coincident with the period of stimulation.

IV A. This curve is an example of intellectual pleasantness. The stimulus was the perception of a tuning fork actuated sympathetically by another fork. The *V* begins low, and had already begun to rise before the stimulus was applied. It continues to rise throughout the period of stimulation, reaching a maximum after the stimulus has ceased.

The result of this examination is that out of seven curves of pleasantness in only three is there an unequivocal rise in *V* coincident with the period of stimulation. And in each of these curves there is some questionable circumstance. In I B and IV A the *V* was low and had already begun to rise when the stimulus was applied. In III C, the rise in *V* follows a marked fall in *V*.

Lehmann gives fifteen examples of *Lustzustände* in the *Körp. Äuss.*

psych. Zustände. These experiments are described in the text, pp. 131-136. The list of curves, with the initials of the observer and the stimulus, is as follows.

1.	XLIII D.	P. L.	Smell of saffron.
2.	XLIII E.	P. L.	Nitrobenzol.
3.	XLIV A.	A. L.	Menthol.
4.	XLIV B.	A. L.	Chloral.
5.	XLIV C.	P. L.	Patchouli.
6.	XLIV D.	S. N.	Attar of roses.
7.	XLV A.	A. L.	Saffron.
8.	XLV B.	Dr. B.	Menthol.
9.	XLV C.	A. L.	A bit of sugar.
10.	XLV D.	P. L.	Powdered chocolate.
11.	XLVI A.	H. K.	Chocolate cake.
12.	XLVI B.	P. L.	Cheerful tune.
13.	XLVI C + D.	A. L.	Colored photograph.
14.	XLVI E.	A. L.	Spontaneous pleasant memory.
15.	XLVII A.	A. L.	Satisfaction at solution of easy problem.

No. 1. About nine seconds after the beginning of stimulation, the curve reaches its lowest level. It then rises sharply, reaching the normal level eighteen seconds after stimulation and finally exceeding the normal *niveau*.

No. 2. There is a slight rise in *V* just after stimulation, followed by a fall in *V*, which remains low. Lehmann does not call this a rise.

Nos. 3, 4, 5. Show short, sharp rises in *V* either in part coincident with the stimulus or entirely so (as in No. 5).

No. 6. There is a slight rise in *V* coincident with the stimulus. But one can hardly refrain from the thought that had the stimulus occurred a few seconds earlier, under a respiratory oscillation, the result would have been just as good.

No. 7. The *V* rises sharply out of the normal level coincident with the first half of the period of stimulation. It falls during the last half of the stimulation, reaching a lower level than the normal.

No. 8. A very decided fall in *V*, which Lehmann suggests may be due to the very long deep respiration and strain of attention.

No. 9. The stimulus is followed by a long, low fall in *V* which never exceeds the normal level.

No. 10. The stimulus is applied at the lowest point in the curve; the *V* gradually rises, reaching the normal level about eight seconds after the chocolate was tasted, and surpassing the norm.

No. 11. The stimulus is followed by a fall in *V*, which at no time afterwards exceeds the normal level.

No. 12. The *V* falls during half the time the melody was played; it rises during the other half. But it does not exceed the normal level at any time during the period of stimulation. Afterwards it rises considerably.

No 13. Closely resembles No. 12. The *V* is low during the whole period of stimulation; it rises, and remains continuously high, after the exposure of the picture.

No. 14. The *V* begins to rise with the first signal and rises steadily to an acme just above the second signal.

No. 15. The curve rises slightly after the first signal, falls, then begins to rise a little before the second signal. It does not reach a high level at any time.

The review shows that positive rises in *V* coincident with stimulation occur in curves 3, 4, 5, 6, 7, 10, and 14. That is, in seven out of fifteen cases. An examination of all the curves reveals three kinds of

rises in *V*. (i) An initial rise coincident with the period of stimulation. As in curves XLIV A, B, C, D, and XLV A. (ii) A rise when the normal *V* is very low, as in curves XLV D and E. (iii) A rise which follows a more or less prolonged fall in *V*. It seems possible to bring all of these curves, with the exception of XLV D and E, under one head. The general character of the curves is the same. There is a positive rise in *V* or, at least, a tendency to rise just after or along with the application of the stimulus. This initial rise is followed by a fall in *V*, after which the *V* regains the normal level or exceeds it. Instances of this general character are curves XLIII D and E, XLIV A, B, C, D, XL A, B, C (not D), XLVI A, B, C (not E) and XLVII A. All the curves, with two exceptions, conform to this general type. Of course, the three parts of the curve, the initial rise (or tendency to rise), the fall and the subsequent rise may vary considerably in different curves. For example, there is no tendency for the *V* to rise just after stimulation, in curves XLVI A, B and C. But the subsequent fall and rise is, apparently, a constant character of every curve mentioned. Now these two rises, the initial, and the final rise after the fall, permit great latitude of interpretation. If the initial rise is very slight, the expression of the pleasantness is looked for in the final rise, as was the case in XLIII D and XLVI B, C. On the other hand, if the initial rise is considerable, even if the final rise is large, the first rise is called the expression of pleasantness. Witness curves XLIV A, B, C, D, and XLV A. The fall in *V* and subsequent rise occur in these curves as in all the others; but the characteristic expression of the feeling is said to be the initial rise, which in these cases is large. This license in interpretation is responsible for much of the apparent success of the method. So long as the expression of the feeling may be looked for anywhere from 2 seconds to 1 minute, after the time of stimulation, without an exact introspective check on the interpretation of the curve, one must expect that arbitrariness of interpretation with which not only Lehmann but others after him may be justly charged. But, waiving that objection, the fact remains that there are seven positive rises in *V* coincident with the stimulus. This number is not sufficient to establish the correlation, even if those curves were unobjectionable. But it may be urged against them that in the best examples, XLIV A, B, C, and XLV A, the sudden rises occur where there is considerable disturbance of the breathing, due, probably, to the use of olfactory stimuli. And in one case, XLV D, the stimulus was applied when the *V* was very low.

Gent[1] describes four reactions of mixed pleasantness and strain, although only one curve is published. The curves with the initial of the *O* and the kind of stimulus are as follows:

1.	Ch.	Smell of fresh lemon.
2.	Ch.	Menthol.
3.	Ha.	Violet.
4.	Wi.	Violet. (Fig. 13.)

No. 1. We quote Gent's description of these curves, with the exception of the last. "In die Reizphase tritt die Volumcurve ansteigend ein mit wachsenden Pulshöhen und wird in ihrem Fortgange kaum von dem Geruchreiz alteriet. Sobald derselbe sein Ende erreicht hat, sinkt er plötzlich, so dass es den Eindruck macht, als sei der bisherige Hochstand des Niveaus nicht der normale gewesen" (p. 757).

No. 2. "Die Volumcurve tritt ansteigend ohne Spontanschwankungen und Respirations-oscillationen in die Reizphase ein" (p. 758).

[1] Philosophische Stud., XVIII, 757.

No. 3. "Das Beispiel bietet den allgemeinen Zügen nach dasselbe Verhalten dar, wie die bereits besprochenen Beispiele, nur dass hier das Armvolumen nicht ansteigend, sondern mit Neigung zur Senkung in die Reizphase eintritt" (p. 758).

No. 4. The *V* rises very slightly for three pulses, falls for six pulses and rises during the remainder of stimulation, reaching a maximum after stimulation. This curve has the same general character as those of Lehmann already discussed. There are an initial rise, fall, and final rise in *V*. It is an important matter for interpretation to know which of these phases is the essential reaction. Of these four curves there seems to be only one, No. 2, which shows an unequivocal rise in *V* coincident with the stimulus. The first curve is 'scarcely altered' by the smell stimulus. No. 3 yields a fall in *V*. No. 4 is half-rise and half-fall. Yet, on the basis of these experiments, Gent feels justified in concluding that: "Das Gefühl der Lust erzeugt immer ein Anschwellen des Armvolums mit Zunahme der Pulshöhen" (p. 759). Gent has also some *V* curves to show the effect of pleasant emotions. But he concludes that "das Armvolumen zeigt weder ein constantes Steigen noch Sinken" (p. 781).

Gent finds that the feeling of relaxation (*Lösung*) is characterized by a rise in *V*. He describes five experiments with that feeling, the stimulus to which, in every case, is a problem in multiplication. The characteristic reaction is a fall in *V*, while the problem is being solved (*Spannung*), followed by a rise in *V*, which may begin before the problem is solved, and which continues to rise above the normal level after the solution is reached. It is possible that this rise in *V*, after stimulation, is an active expression of the feeling of relaxation, as Gent holds. But it seems more likely that it is a purely passive restoration of physiological equilibrium which has been disturbed by the stimulus.[1] Only one curve (Fig. 8) is published, so that it is not possible to give a detailed criticism. But it seems unlikely that the satisfaction of performing a simple arithmetical operation should express itself by such a powerful and continuous rise in *V* as is shown in Fig. 8, while it is next to impossible, by any sort of pleasant sensory stimulation, to obtain even a very moderate rise in *V*.

We have now finished the review of those instances of rise in *V* on the basis of which a correlation with pleasantness has been established. Féré has published no curves with which we are acquainted, showing the effect of pleasant and unpleasant stimuli on *V*, although he is the author of the correlation. In Lehmann's first work there are three rises in *V* coincident with the stimulus; in his second work there are seven rises coincident with the stimulus. In Gent's curves, there is one rise in *V* coincident with the stimulus. Therefore, there are eleven rises in *V* coincident with a pleasant stimulus in the literature[2] of the expressive method.

This paucity of positive rises in *V* has not escaped other observers. Lehmann says, "It is a well known circumstance that the bodily ex-

[1] *Cf.* Zoneff and Meumann, Phil. Stud., XVIII, 63, for the similar view that after retardation of *P* by pleasantness, *P* tends to increase from purely physiological causes.

[2] Féré cites the results of L'herminier, Études plethysmographiques en psycho-physiologie, Thèse, Bordeaux, 1897, in support of his theory. I have not been able to consult this paper.

pressions of pleasurable states can be demonstrated only with great difficulty. While I found earlier (in the *Hauptgesetze*) that all simple pleasurable feelings are accompanied by increase in V, in addition to increased height of pulse, most later observers in this field have been able to demonstrate no essential difference between pleasant and unpleasant stimuli. As we shall see in the sequel, such a difference does nevertheless exist; and if authors like Kiesow, Shields and Binet are not able to find this, probably a whole series of interesting circumstances is at fault" (*Körp. Aeus. psych. Zust., 128*). Lehmann objects to Binet and Courtier's work that they investigated emotions and that children were observers. He suggests that the difference may have been overlooked by Shields. Lehmann gives four reasons for the paucity of rises in V with pleasantness. (i) It is difficult to set up strong feelings of pleasantness. (ii) Since the feelings are weak the curves must be represented very plainly, especially with reference to length and height of pulse, in order that small differences may be visible. (iii) The observer must be kept in a state of affective equilibrium. (iv) It is impossible to avoid active attention, which has the opposite expression of pleasantness. In reply to these reasons it may be said (i) that it is true that the objective expression of pleasantness is difficult to secure. Such, at least, has been the experience of the Cornell Laboratory.[1] But to attribute this difficulty to the weakness of the pleasantness during the experiment without valid reasons for the attribution and in face of the fact that in ordinary life pleasantness is easily excited is almost a question begging argument. (ii) This does not apply to V but merely to changes in length and height of pulse. (iii) This is undoubtedly true. (iv) This reason involves a discussion of the relation of attention to feeling, which is not within the province of this paper, and in the second place, although it may be a difficulty, Lehmann himself has proved that it is not insuperable, by the fact of his own curves.

III. Summary of Conclusions.

The fourth physiological symptom with which this paper is concerned, namely, depth of breathing, must remain the sole characteristic, the validity of which is not impugned either by our own results or those of other observers. As we have already said, with a few exceptions it is the universal characteristic of active attention. The position of this paper, therefore, with regard to the four physiological symptoms may be summarized in three theses.

(i) Changes in rates of P and R are brought about by the psychophysical process of sensation.

(ii) Every sensory stimulus (probably in proportion to its intensity) tends to produce a fall in V.

(iii) Inhibited R is a characteristic of active attention.

IV. Classification and Discussion of Equivocal Cases.

A classification and analysis of the equivocal cases brings out some interesting relations as to the sensitiveness to change

[1] *Cf.* Titchener, Exp. Psych., Instructor's Manual — Qualitative, 181, for a curve of pleasantness.

of the circulatory and respiratory functions. We assume that if either function reacts pliantly to the conditions of the experiment, there will be few equivocal cases. On the other hand, if the function is inert, there will be many equivocal cases. The following Table shows the total number of experiments in each sense department, together with the number of equivocal reactions of *P* and *R*.

TABLE V.

Stimulus	Equivocal Cases		Number of Expts
	R	P	
Masson disc	5	5	14
After-image	4	7	12
Radii of circle	2	5	10
Radii with intrinsic interst	1	2	7
After-image with intrinsic interest	3	5	7
Questions in philosophy	2	4	6
	17	28	56
Difference tone	1	4	8
Watch from out in	1	1	7
Watch from in out	1	1	5
End of tone	1	4	10
Counting beats	3	4	8
	7	14	38
Cold spots	1	1	8
Minimal pressure	2	1	4
Comparing size of cylinders	1	0	3
	4	2	15
Multiplication	2	3	7

The Table shows that there are fewer equivocal cases of *R* in the visual and auditory experiments than there are equivocal cases of *P*. On the other hand, there are more equivocal cases of *R* in the tactual group than of *P*. This result, if our assumption as to the meaning of an equivocal case is correct, means that the respiratory function is more sensitive to auditory and visual stimuli than is the cardiac function; but that the heart responds more readily to tactual stimuli than does respiration. The Table also shows that the total number of

equivocal cases with relation to the whole number of experiments is less in the tactual and auditory experiments than in the visual. The proportion is 45:57 for visual; 21:38 for auditory; and 6:15 for tactual. This fact would seem to indicate that both *P* and *R* respond less readily to visual stimuli than to tactual and auditory stimuli.

V. Remarks on the Experiments with Intrinsic Interest and on the Attitude Experiments.

It remains to say a word about the experiments with intrinsic and natural interest, and the 'attitude' experiments. The former experiments were suggested as a means of varying the central conditions of attention while the peripheral conditions remained the same. It was thought that if peripheral factors were the cause of the changes in rate of *P* and *R*, the case would be strengthened if it was shown that a wide variation of central conditions made no essential difference in the results. Of course, such a conclusion is valid only on the assumption that the central conditions would express themselves differently from the peripheral conditions. Apparently, the variation in conditions made no marked difference in result. The latter experiments were instituted with a view to showing whether it is possible for the same observer to give consistently different reactions to the same stimulus. If it were possible, it was thought that it would show a possible ground for the discrepancies with which the literature of the expressive method abounds. The changes in *V* and depth of *R* show no differentiation according to attitude. The reaction for the most part is fall in *V* and inhibited *R*. The rates of *P* and *R* for the indifferent attitude do not change consistently within the group, although the pulse shows an evident slowing. The active and the affective attitudes, however, are differentiated quite sharply by the changes in rate of *P*, which in the active attitude is faster (except one reaction), and in the affective attitude is slower.

VI. Concluding Remarks.

The writer, after consideration and in the light of all the facts, has felt under the necessity of saying that the method of expression as applied to the study of the feelings and of attention has failed. When one compares Lehmann's extravagant suggestion[1] with the actual state of this branch of Psy-

[1] "Sind alle diese Erscheinungen erst untersucht und ihre characterischen Aeusserungen festgestellt, so wird man am Plethysmographen ein wirkliches Psychoskop besitzen, einen Apparat, mittels dessen man mit nicht geringer Sicherheit den Gemütszustand einer Person zu diagnostizieren vermag." *Körp. Aeuss.*, etc., text, p. 216.

chology, one cannot but wonder at his temerity. If the position which the writer has taken with regard to the changes in rate of pulse and of respiration and in volume is correct, the plethysmograph will never serve as a psychoscope for the diagnosis of affective processes. And if by any means the method is rehabilitated, it will require more rigorous rules of use than have yet obtained, to secure results of any degree of certainty.

D. Appendix.

Table VI was made in support of the statement that a long series of investigations with the method of expression had ended in contradictory or negative results. The negative results are those of Shields, Binet and Henri, Binet and Courtier, Angell and Thompson and Bonser. The contradictory result is that of Külpe, as regards the rate of pulse in unpleasantness, and that of Gent, as regards rate of pulse for pleasantness. The height of pulse in pleasantness and unpleasantness is consistent for those who have observed it. But many have failed to observe it at all. Zoneff and Meumann alone find an opposition in rate of respiration between pleasantness and unpleasantness. Binet and Henri and Binet and Courtier found no differentiation. 'Lehmann found an increased height of respiration the characteristic of pleasantness in his earlier work. He does not confirm it in his second work. Zoneff and Meumann find the opposite change in height of respiration for pleasantness. For changes in *V* Lehmann agrees with himself and with Gent. Féré, apparently, has not published any affective curves. Angell and McLennan's results are not stated precisely enough for treatment. The other observers have either found vasoconstriction for all stimuli or they deny any kind of correlation.

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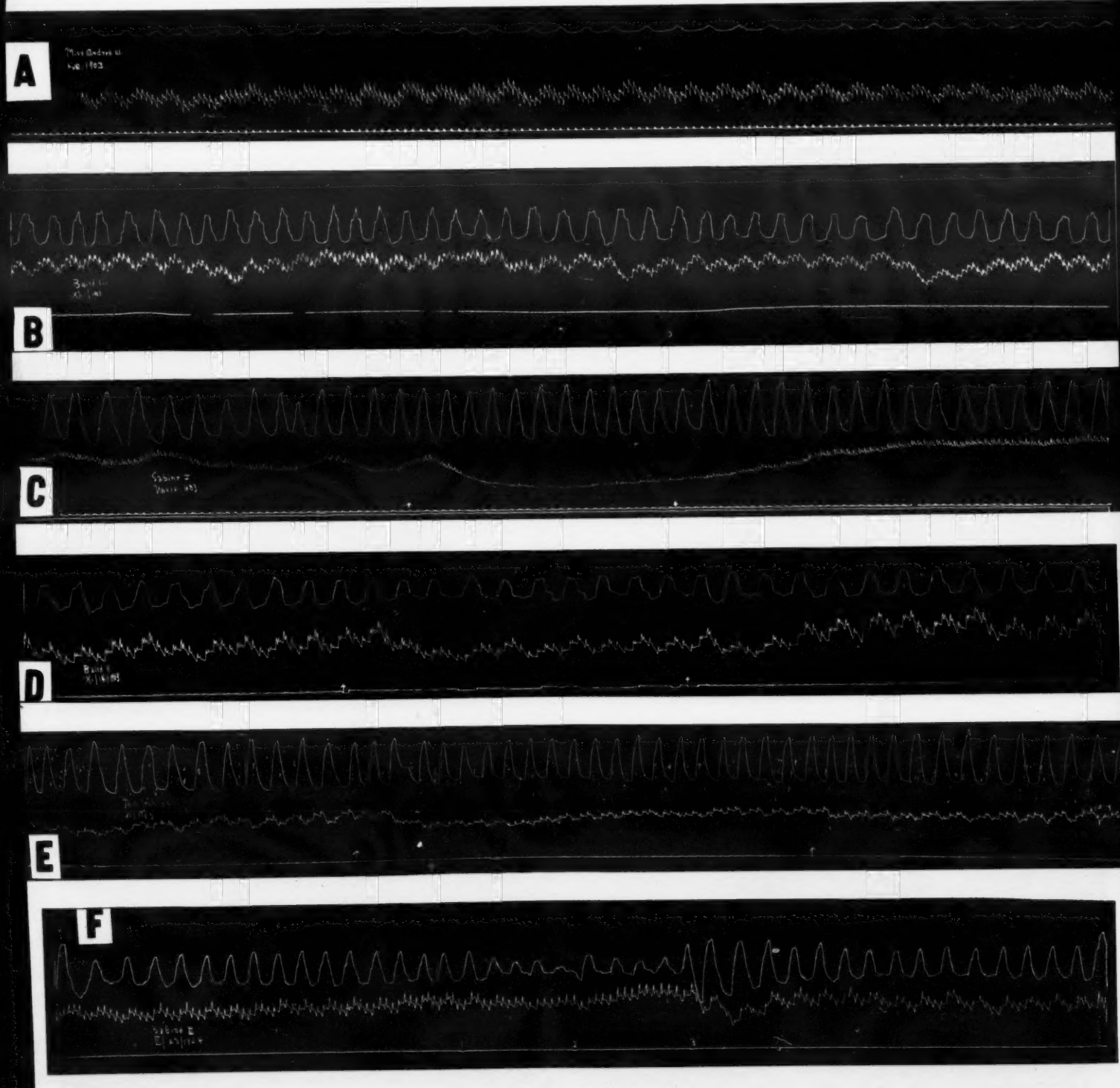
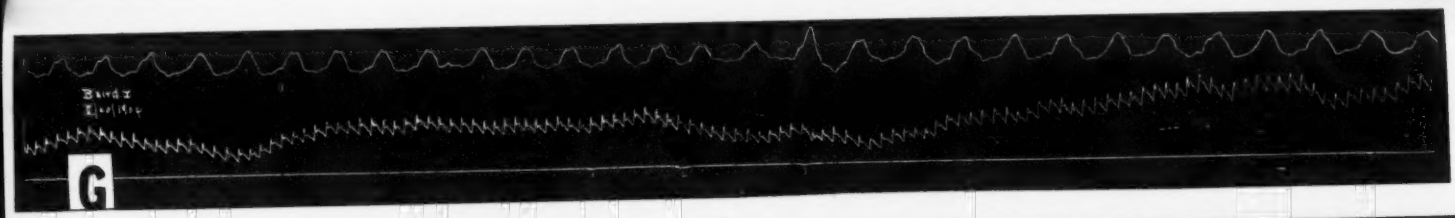
TABLE VI.

Investigator		Affection	Pulse		Respiration		Volume
			Rate	Height	Rate	Height	
Féré	1887	Pleasantness					+
		Unpleasantness					−
Lehmann	1892	Pleasantness		+		+	+
		Unpleasantness		−			−
Külpe	1893	Unpleasantness	−				
Mentz	1895	Pleasantness	−				
		Unpleasantness	+				
Shields	1895	Pleasant or unpleasant odors					−
Binet and Henri	1895	Pleasant or unpleasant emotions	+		+		−
Binet and Courtier	1896	All emotions pleasant or unpleasant	+		+		−
Angell and McLennan	1896	Disagreeable					− 90%
		Agreeable					+ ? %
Angell and Thompson	1899	Pleasantness or unpleasantness	No correlation				−
Lehmann	1899	Pleasantness	−	+			+
		Unpleasantness	+	−			−
Zoneff and Neumann	1901	Pleasantness	−		+	−	
		Unpleasantness	+		−	+	
Brahn	1901	Pleasantness	−	+			
		Unpleasantness	+	−			
Gent	1903	Pleasantness	±	+			+
		Unpleasantness	+	−			−
Bonser	1903	Affective stimuli					−

Bonser	1903	Affective stimuli					—





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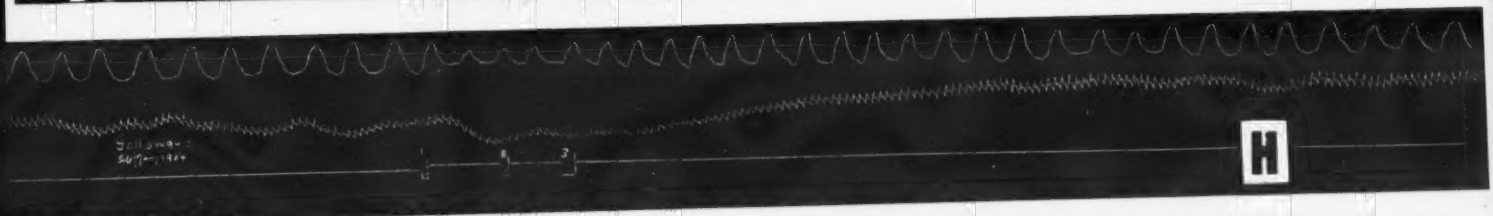

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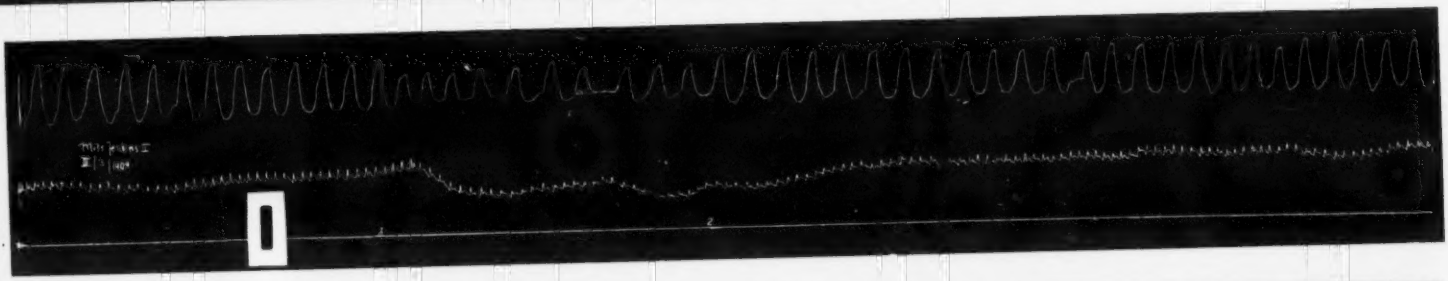

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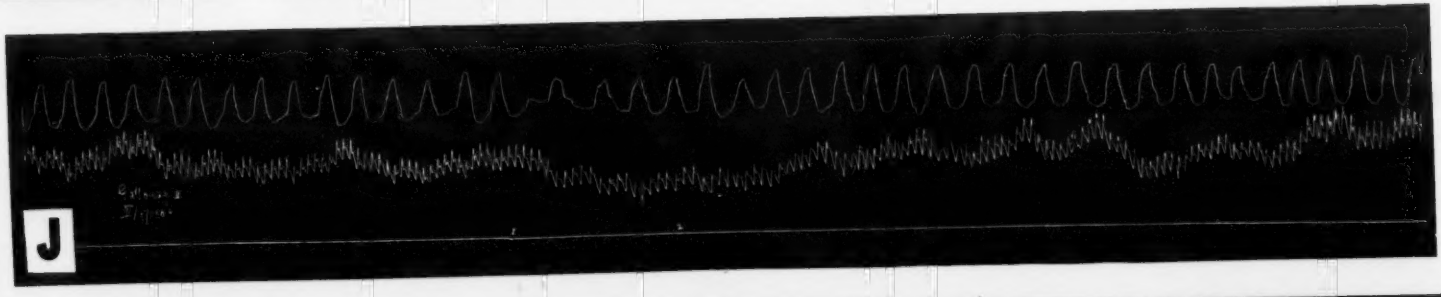

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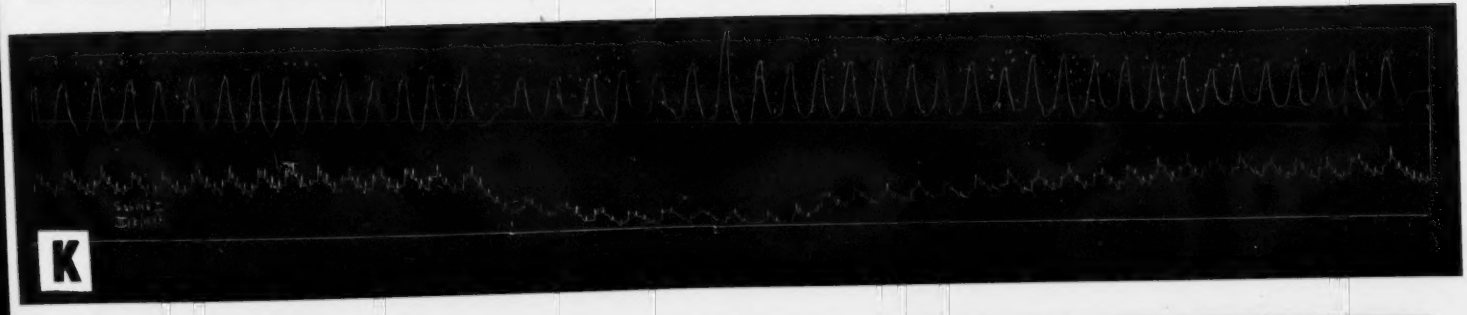

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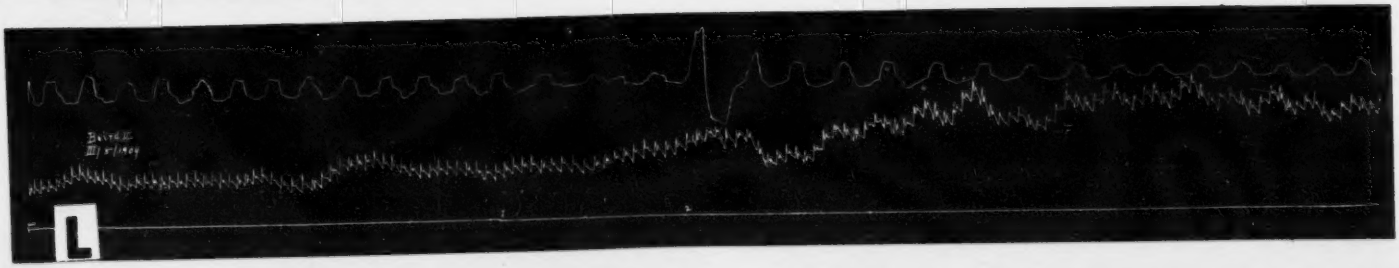

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ILLUSTRATIVE SERIES OF TWELVE CURVES.

All curves read from left to right. *A* and *B* are normal curves without stimulus. In *A*, only one tambour of the pneumograph was functioning; hence the small breathing curve. About ten seconds of the pneumogram and plethysmogram were lost at the beginning of *A*, because the writing styles were not in contact with the drum. *C*, *D* and *E* are reactions to the Masson disc. The reaction is represented by the space between the arrows. That part of the curve between the beginning and the first arrow is the normal period; that between the second arrow and the end is the recovery period.

F, *G* and *H* are auditory reactions. In *F*, the stimulus attended to was a watch tick. At 1, the watch was moved away from *O;* at 2, it was inaudible; the watch was then moved toward *O* until it became audible at 3. In *G*, the stimulus attended to was beats. At 1, the forks were actuated; at 2, *O* began to count the beats; at 3, the beats ceased to be audible. In *H*, the stimulus attended to was a watch tick. At 1, *E* began to move a watch toward *O;* at 2, *O* heard the watch; it was then moved away from *O*, until it became inaudible at 3.

I, *J*, *K* and *L* are reactions to tactual stimuli. The stimulus attended to in *I* and *K* was a cold cylinder; in *J* and *L*, von Frey's pressure hair.

By a mistake of the engraver, the curves, instead of being reproduced full-size, have been reduced one-half.

A STUDY IN TONAL ANALYSIS. I.

By I. Madison Bentley and George H. Sabine.

(From the Psychological Laboratory of Cornell University.)

The experiments on which the present study is based are directed toward the general problem of the psychophysical analysis of tonal stimuli, a problem which finds its natural setting in the conflict of current theories of audition. The primary function of a psychophysical theory of audition is the explanation of analysis. Except under unusual conditions, the stimulus presented to the ear is complex; but, if the stimulus is periodic, it is, as a rule, broken up by the auditory apparatus into simpler components, each of which gives rise to a single simple sensation of tone. The first task of auditory theory lies, therefore, in the establishment of the physical and physiological conditions underlying the production of these simple tonal sensations.

The traditional theory of Helmholtz considers the ear as a resonance mechanism, which analyzes complex periodic disturbances in the sense of Ohm's law. That is, the theory regards the auditory apparatus as a mathematical analyzer of great capacity and precision. The resonance theory, now almost a half century old, was a stroke of genius. By the application of a comparatively simple physical principle it rationalized a large and tangled mass of facts. It is not, however, without its weak points. The number of facts which any adequate theory must take into account has increased enormously in recent years, and, in some respects, the facts may be said to have outgrown the theory as Helmholtz propounded it. The result is a bewildering number of new theories. Some of these are modifications of the traditional theory; they are built upon Helmholtz's foundation.[1] Others reject the principle of sympathetic analysis by tuned fibres, and offer in its

[1] *E. g.*, H. Ebbinghaus, *Psychologie*, I, 313 ff. L. Hermann, Zur Theorie der Combinationstöne, *Arch. f. ges. Phys.*, XLIX, 499 ff.; Beiträge zur Lehre von der Klangwahrnehmung, *Ibid.*, LVI, 467 ff. H. Ayers, Vertebrate Cephalogenesis. II. A Contribution to the Morphology of the Vertebrate Ear, with a Reconsideration of its Functions, *J. of Morph.*, VI, 1 ff. C. Stumpf, *Tonpsychologie*, II, 480 ff.

place some other means of analysis.[1] The general objection to Helmholtz is that he demands too much of the auditory mechanism. Thus Ebbinghaus maintains that the vibrating fibres are less elastic, and therefore that sympathetic resonance is more susceptible of disturbance than Helmholtz had supposed. The more freely and independently the fibres respond, he argues, the less clearly and completely will they analyze the initial stimulus. Again, Max Meyer objects that our knowledge of physical objects does not warrant the assumption that bodies so minute as the basilar fibres can vibrate sympathetically to tones lying near the lower limit of audition. The usual argument that the difference between the high and low fibres is to be explained by difference of load, is not justified, he thinks, by any known physiological facts, though the loading required for this purpose would be very great. Meyer holds, moreover, that the Helmholtzian theory is incapable of explaining certain important phenomena brought to light by recent studies of combination tones.

The general facts of auditory analysis are patent and all current theories attempt to meet them; but the degree and the facility of analysis of which the auditory apparatus is capable are still matters of dispute, and it is clear that no definitive theory of auditory sensations can be formulated until the limits and accuracy of tonal analysis are better known than they are at present. In view of this fact, it occurred to the writers that a study of analysis under somewhat unusual conditions might throw light on this most fundamental problem of auditory theory. The unusual conditions were to consist in using as a stimulus a simple periodic vibration of constant rate but of regular and rapid changes of amplitude. It seemed probable to the experimenters that the ear might be expected to solve this rather difficult problem differently according as it proceeded by resonance or by some less delicate and less accurate means of analysis.

Preliminary Experiments.

Since our stimulus was to be as simple and controllable as possible, we decided against Kœnig's siren disc method, which

[1] *E. g.*, Max Meyer, Über Kombinationstöne und einige hierzu in Beziehung stehende akustische Erscheinungen, *Zeit. f. Psych. u. Phys. d. Sin.*, XI, 177 ff.; Zur Theorie der Differenztöne und der Gehörsempfindungen überhaupt, *Ibid.*, XVI, 1 ff.; Über die Intensität der Einzeltöne zusammengesetzter Klange, *Ibid.*, XVII, 1 ff. Emile ter Kuile, Die Übertragung der Energie von der Grundmembran auf die Haarzellen, *Arch. f. ges. Phys.*, LXXIX, 146 ff.; Die richtige Bewegungsform der *membrana basilaris*, *Ibid.*, 484 ff. J. R. Ewald, Zur Physiologie des Labyrinths. VI. Mitth. Eine neue Hörtheorie, *Arch. f. ges. Phys.*, LXXVI, 147 ff.

compounds a series of shocks or puffs grouped in periods of variable intensity.[1] For a similar reason, we soon abandoned the interruption method of varying, by means of a rotating disc, the intensity of a continuously sounding tuning fork.[2] We regarded this method as particularly objectionable for preliminary work, inasmuch as it involves the interruption or interference tones.[3] The tuning fork without the disc promised a simpler and more easily controlled source of sound. The tuning fork is, however, extremely rigid, and does not, therefore, easily and quickly yield to differences of strain from external force.

Two methods were used to overcome this difficulty and to induce rapid and periodic oscillations of intensity from the sounding fork. In the first method, the fork employed as stimulus was immersed in heavy oil and provided with a small temporary magnet placed between the ends of the prongs. The magnet was put in the circuit of an actuating fork whose period was one-half or one-third the period of the stimulus-fork. The stimulus-fork was thus driven (by arranging the contact-time of the primary fork) every second or third vibration, and immediately damped by the heavy oil in which it was immersed. The fork was provided with a short writing point and recorded its movements immediately upon a kymographic drum. It was found impossible, however, to damp the stimulus-fork, by this means, in the short intervals between the successive contacts of the slower fork. Further to offset the high elasticity of the stimulus-fork, a second circuit, with a second primary fork, was introduced in such a way that one magnet set between the prongs, and a pair of magnets set opposite the outer faces of the fork, tended to produce alternate rest and motion of the prongs (second method). High stress within the fork again defeated our aim, the fork writing a compound curve which represented the superposition of the rates of the two primary forks upon the proper rate of the stimulus fork itself. In both of these experiments the cores of our magnets reproduced very clearly the tone of the actuating fork, thus complicating the stimulus.

This direct means of producing periodic changes of amplitude was now abandoned and a third method introduced. In the new method, a tuning fork was revolved at a constant rate about the longitudinal axis of its stem.

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[1] R. Kœnig: *Quelques expériences d'acoustique* (1882), 131 ff.

[2] *Cf.* K. L. Schaefer and O. Abraham, Studien über Unterbrechungstöne, *Arch. f. ges. Phys.*, LXXXIII, 207 ff.; LXXXV, 536 ff.; LXXXVIII, 475 ff.; R. Kœnig, *op. cit.*, 138 ff.

[3] The term 'interruption tone' seems to come from Stefan. See Über einen akustischen Versuch, *Sitzungsber. d. kais. Akad. d. Wiss. zu Wien* (Math.-naturwiss. Cl.), 1866, LIII, Abt. 2, 703.

The Literature of the Rotating Fork.

Experiments with rotating forks are by no means new. As early as 1825, E. H. and W. Weber described in their *Wellenlehre* such an experiment, as follows: "If a tuning fork is put into a lathe so that it can be rotated about the longitudinal axis of its stem, it is found that the fork ceases to sound when a certain rate of rotation is reached, but that the tone reappears if the lathe is suddenly stopped. This is not to be explained by supposing that the noise of the lathe drowned the fork, for if one brings the end of a cylindrical tube close to the prongs of the fork and puts the other end to the ear, one is convinced that the rotation does not destroy the vibration of the fork, but prevents its transmission to the air. We can give no explanation of this remarkable phenomenon."[1]

W. Beetz next took up the work and repeated the experiment of the Webers.[2] He did not find, however, that the tone of the fork disappeared, but only that its intensity was diminished. He heard also a higher tone and a series of puffs, equal in number to double the number of rotations of the fork. He was not able to explain the phenomenon. Later Beetz again took up the experiment,[3] using two forks of 512 and 1024 vibrations per second. When these forks were rotated about twelve times per second, Beetz found that the pitch of the lower fork was raised about three-fourths of a tone, and the higher about a half tone. He heard again the beats, two for every revolution of the fork. The phenomenon, he holds, is not to be connected with the transmission of the vibrations of the fork to the air, for one hears the rise in pitch just as well, or better, when one lays one's head on the lathe and stops one's ears entirely. Beetz attempts to explain the rise in pitch by the supposition that the fork here becomes a special case of the Foucault pendulum. In a later investigation[4] he explains that he has discovered a source of error in his experiments which renders this explanation impossible. He also points out the existence of certain lower tones, apparently subjective, which would also be inexplicable by the theory of the Foucault pendulum. Accordingly, after repeating all his experiments, Beetz attempts to get an explanation from Doppler's law in regard to changes of pitch with a moving source of sound. The tonal qualities present with the revolving fork could very well be explained in this way, but Beetz was entirely unable to make out any quantitative cor-

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[1] Quoted by W. Beetz in an article Über die Töne rotirender Stimmgabeln, *Poggendorff's Annalen*, 1866, CXXVIII, 490 ff., and referred by him to the *Wellenlehre*, 510. The same reference is given by Stefan, Nachtrag zu dem Aufsatze: Über einen akustischen Versuch, *loc. cit.*, LIV, Abt. 2, 600. Exner and Pollak (Beitrag zur Resonanztheorie der Tonempfindungen, *Zeit. f. Psych. u. Phys. d. Sin.*, XXXII, 310) also quote the passage and refer it to the *Wellenlehre*, 110. Since the Webers' book is not at our disposal, we cannot tell which reference is correct.

[2] This was described in a paper before the Physical Society at Berlin, July 4, 1851; mentioned in *Die Fortschritte der Physik*, VI u. VII, 1850-51, viii.

[3] Über die Töne rotirender Stimmgabeln, *Poggendorff's Annalen*, 1866, CXXVIII, 490 ff. This was translated into English with a note by G. C. Foster, *The Philosophical Magazine and Journal of Science*, 1866, Series 4, XXXII, 534 ff.

[4] Über die Töne rotirender Stimmgabeln. Zweite Notiz. *Poggendorff's Annalen*, 1867, CXXX, 313 ff.

respondence. The observed intervals were much too large for those computed by Doppler's formula.

While Beetz was performing these experiments, J. Stefan also was carrying on investigations of a similar nature.[1] He found that, if a vibrating plate were rotated before the ear,[2] the characteristic tone of the plate disappeared and was replaced by two tones, the one higher, the other lower, than the primary. The higher is usually the stronger of the two, and the primary tone is sometimes audible along with the lower and higher tones. The same phenomenon is heard with a rotating tuning fork. The phenomenon to be explained, according to Stefan, is the effect upon the ear of a tone of periodically varying intensity. The movement which a tone of constant intensity produces in a body vibrating in sympathy with it can be expressed in the formula

$$a \sin 2\pi n (t+\theta)$$

where n = vibration rate, t a variable and θ a constant time, and a the amplitude of vibration. If the intensity varies periodically, a becomes a periodic function of t and in the simplest case can be expressed as

$$a \sin 2\pi n' (t+\theta');$$

n' being the number of intensity changes in a unit of time. a is then a constant quantity. If, now, one substitutes this formula for a in the first, one gets for the excursion of the sympathetically vibrating body

$$a \sin 2\pi n' (t+\theta') \sin 2\pi n (t+\theta)$$

or

$$\frac{a}{2} \cos 2\pi (n-n') (t+\theta_1) - \frac{a}{2} \cos 2\pi (n+n') (t+\theta_2).$$

But each of these expressions represents a simple pendular vibration, the one having a vibration rate of $n-n'$, and the other a rate of $n+n'$.[3] By actual observation, Stefan found that his lower and higher tones corresponded in pitch to the demands of this explanation.

In a second article,[4] Stefan describes some other experiments in which he produced periodic changes of intensity by rotating a perforated disc before a sounding fork, and gives credit to those who had preceded him in the work with rotating plates and forks. Meanwhile Radau,[5] without performing any experiments, had anticipated Stefan's calculation and reached the conclusion that a tone varying periodi-

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[1] Über einen akustischen Versuch, *Sitzungsber. d. kais Akad. d. Wiss. zu Wien* (Math.-naturwiss. Cl.), LIII, Abt. 2, 696 ff.

[2] Stefan also rotated a sector over the plate at rest, getting the same result.

[3] *Cf.* Rayleigh's analysis of the wave obtained by interrupting the tone of a fork with a perforated rotating disc. He finds it to be composed of three simple vibrations, having the frequencies n, $n+m$, and $n-m$, where n = the rate of the fork and m the number of intermittences. Acoustical Observations, III, *The Philosophical Magazine and Journal of Science*, 1880, Series 5, IX, 278 ff. *Cf.*, also, *The Theory of Sound*, 2d ed., I, 1894, 71 ff.

[4] Nachtrag zu dem Aufsatze: Über einen akustischen Versuch, *Sitzungsber. d. kais Akad. d. Wiss. zu Wien* (Math.-naturwiss. Cl.), LIV. Abt. 2, 597 ff.

[5] *Moniteur scientifique*, 1865, 430. So Stefan (*Ibid.*, 598) gives the reference; Exner and Pollak (*loc. cit.*, 312) refer it to the same year, 136. We have not had access to a file of the periodical.

cally in amplitude should produce the two tones which Stefan actually found. Radau coined the name 'variation tones' for the phenomenon. Stefan recognizes also the priority of the work of the Webers and of Beetz.

Upon the appearance of Stefan's articles, Beetz again took up the experiments with a view to testing the hypothesis of Radau and Stefan.[1] Finding the hypothesis well borne out with rotating plates, he turned again to rotating forks to determine whether they too gave the tones to be expected from Stefan's formula. He found that the lower tone as observed corresponded approximately to the calculated tone. The higher tone, however, was always much higher than the theory required. The difference between the observed and calculated values became very large with rapid rates of rotation. Beetz found, however, that the difference became trifling when he took his observations with a resonator having an opening 5mm. instead of 25mm. in diameter. With such a resonator the observed values coincided very closely with the values computed by Stefan's formula. Beetz used three forks, $c_1 = 256$, $a_1 = 440$, $c_2, = 512$, and three rates, 6.5, 13, and 19.5 revolutions per second. He took, also, some observations for two very low forks, 64 and 77 vibrations. In almost every case, Beetz's observed values are larger than the calculated values. In this last paper, Beetz accepts Stefan's and Radau's explanation of the phenomenon.

All the experiments described above were undertaken by physicists in the interest of a physical theory of sound. The most recent investigation with the rotating fork is that by Exner and Pollak,[2] of the Physiological Institute of the University of Vienna, who use it in the interest of a psychophysical theory. They propose to test the resonator theory of audition by using simple tones with periodic reversal of phase. They reason as follows. When a wave train acts on a properly tuned resonator, the effect, up to a certain limit, is cumulative; *i. e.*, each successive wave increases the sympathetic vibration of the resonator until the limit is reached. If, however, the wave suddenly changes phase, its energy will be directed against the inertia of the resonator, and the two will oppose one another until equilibrium is reached, after which the wave will again produce on the resonator its former cumulative effect. If, now, this change of phase is made periodically, it should result in a wave with much smaller amplitude than the original wave, periodically varying in intensity, unless the phase changes follow one another so closely that the wave is entirely annihilated. Hence it should follow that, if audition is mediated by a series of resonators, a tone thus interrupted should be discontinuous and we should hear bursts of sound alternating with periods of silence. It should follow further that, by keeping the intensity of the tone constant and increasing the frequency of the phase changes, we can cause the tone to decrease in intensity until it entirely disappears. That is, the cumulative effect on the basilar resonators of the waves falling between any two successive phase changes will not be sufficient to raise the nervous impulse above the limen of sensibility. If, now, the number of phase changes is kept constant and the physical intensity of the tone is increased, the tone which has become just inaudible should be lifted over the limen.

Exner and Pollak used three forms of experiment to obtain the conditions which they required: (1) a tuning fork rotated about the

[1] Über den Einfluss der Bewegung der Tonquelle auf die Tonhöhe, *Poggendorff's Annalen*, 1867, CXXX, 587 ff.

[2] Beitrag zur Resonanztheorie der Tonempfindungen, *Zeit. f. Psych. u. Phys. d. Sin.*, XXXII, 305 ff.

longitudinal axis of its stem and having, therefore, four phase changes for each revolution; (2) a stationary fork which actuated a telephonic diaphram under a current which was periodically reversed by means of a rotating commutator, thus causing two changes of phase at each rotation; (3) a rotating stop-cock which brought alternately to the ear the waves from the side and from the face of a continuously sounding fork. The results reached by these methods confirm the authors' hypothesis regarding auditory resonance. They found that the sudden reversal of phase, when it comes with sufficient frequency, destroys the tone. A critical rate of phase-change was discovered. At this rate (which was fairly constant under the given conditions) the sound of the tuning fork disappeared, and reappeared only when the rate of revolution was diminished.

It will readily be seen, now, that the purpose of the Viennese investigators coincided approximately with ours; it was, namely, to place the observer under a set of conditions so unusual and at the same time so well controlled that the result should serve as an *experimentum crucis* of the theory in question. Notwithstanding this general coincidence, we shall proceed at some length with the discussion of our own experiments, both because we have laid greater emphasis upon the introspective record and because we have considered additional points of method and of interpretation.[1] The two sets of results present, as we shall see, important and fundamental differences. Before passing to our own experiments, we should repeat, for the sake of clearness, that the theoretical conclusions which Exner and Pollak draw are based wholly upon the sudden changes of phase which the tonal stimulus, as produced by the rotating fork, undergoes; we have found it necessary, however, to consider not only phase changes but also the periodic variations of amplitude, which seem to us to be of no less importance in the psychophysical interpretation of the acts.

New Experiments with the Rotating Fork.

Apparatus and Method. In most of the observations recorded below, a Kœnig fork of 384 double vibrations (Sol_3) was used; a Kœnig fork of 128 (Ut_2) was employed, however, in a few minor determinations (see p. 493). The higher fork was set horizontally[2] in close-fitting, Y-shaped bearings, the stem of the fork being inserted in a hollow steel shaft, 11 cm. long and 12 mm. in diameter. The hollow end of the shaft was split across one diameter and the fork-stem was held in place by means of a collar and set-screw. The end of the shaft opposite the fork was provided with a compound pulley wheel of three grooved discs whose diameters approximated respectively 2.5, 5, and

[1] The problem was already well under way when the report from the Vienna Laboratory came to our notice.

[2] The lower fork because of its great weight was set upright.

7 cm. The base of the Y-shaped bearing was screwed to a heavy block of wood, which, in turn, was secured to the surface of a solid bench. The fork and shaft of the rotator were driven by a belt-gear apparatus with six wheels. The highest and lowest rates required more gear-wheels and a cone-reducer. The whole apparatus was turned by hand. Its rate was kept constant by turning in unison with the sound of a metronome conveyed from an adjoining room through a tin speaking tube, which terminated in two rubber tubes for the ears of the experimenter. The sound of the metronome was not audible to the observer. The rate of the rotating fork was registered by means of a speed indicator set directly into the end of the shaft opposite the fork. By varying the metronome rates and shifting the gearing, the writers were able to produce with great constancy any rate of revolution between the limits of ten and eighteen hundred in the minute (.6 and 30 in the second). Both investigators served alternately as experimenter and observer, each rate being both produced and read off at least once by each of them. No observations were made where the two readings on the indicator varied more than ten revolutions in the minute. For the slower rates the range of error was five revolutions or less.[1]

When once the rate had been determined, the fork was struck with a felt hammer, damped near the base to eliminate overtones, and set into rotation by one of the writers. As soon as the swing of the metronome had been caught, a signal was given to the observer who brought a Kœnig resonator near the side of the revolving fork and adjusted the length of the resonator until the resonance was maximal. After this a full introspective account of the tone was given. In case two or more tones were present, the point of maximal resonance for each tone was determined. Full observations were taken by both of the investigators at each rate. It was found that after some preliminary practice the place of maximal resonance could be determined with considerable accuracy. Since, however, the permanent calibration on the resonators was found to be unreliable, the resonators were standardized with a set of Kœnig forks (the same 'maximal resonance' method being used) and the intermediate spaces on the resonator were corrected by reference to the new standards. The two observers agreed well in the choice of points of maximal resonance.

[1] This mode of rotating the fork was adopted after various electrical devices had been tried and rejected. The writers were, at first, confident of improving on Alfred M. Mayer's primitive hand-rotator for driving disc sirens; but they learned, in the course of their experiments, to appreciate the wisdom and judgment of this clever and accurate acoustician.

Where the final settings of the resonator differed slightly, the mean of the two settings was taken as the basis for calculation. It was, of course, inevitable that the two observers should sometimes differ, for maximal resonance is an area, not a line. This means of determining the vibration rate of a given tone involves a certain range of error, due (1) to the magnitude of the limen for intensive differences; (2) to the comparatively wide selectiveness of the resonator; and (3) to the unjust divisions of the areas between the standardized values (*e. g.*, between maximal resonance points for Sol_3 and La_3, Sol_3 and Fa_3, etc.).

In regard to the defects of the resonator method, we may say that, in the first place, it was the best that our materials offered, and was used while we were waiting for more adequate means of control with which to continue our study. In the second place, the method gave results; and, in the third place, it was possible to check it from time to time, and thus to standardize the actual error involved.[1]

Introspective Results and their Interpretation.

I. The lowest rates of rotation gave precisely what one hears by revolving a sounding fork slowly before the ear: four bursts of tone separated by intervals of weak sound.[2] Our fork gave a more intensive tone from the faces than from its narrow edges and, as a result, the four bursts of sound were alternately strong and weak, giving in all eight intensities (2 maximal, 4 minimal, and 2 medium) at each revolution. At a moderate rate (about 80 revolutions in the minute) the minimal intensities disappear, leaving two maximal and two medium or moderate intensities. Thirdly, at about 225 revolutions the separate pulses of sound disappear, leaving a rough, noisy, throbbing complex, which resolves itself into a higher tone (A) and a lower tone (C). With a higher rate, there appears between these two tones a complex of tone and noise which, with a further separation of A and C, becomes the tone B. The pitch of tones A and C diverges more and more, as the rate of rotation is increased.

II. In counting the beats produced by B and a second, stationary fork of 384 vibrations, it was found that the actual drop of B was less than the drop observed with the resonator. This may be accounted for by the indefinite quality of B and the consequent difficulty of obtaining exact maximal resonance,

[1] The writers hope to be able to present in a second paper full numerical results obtained under an adequate method of control.

[2] *Cf.* H. von Helmholtz, *Sensations of Tone*, Trans. by Ellis, ed. 1895, 161.

and also, perhaps, by an error of expectation, which may have been influential after a decline in pitch was once noted.

III. The results show a conspicuous parallelism between the rise and fall of tones A and C, and between these and the gradual acceleration of the rate of rotation. The drop in C seems to be uniformly more rapid than the rise in A and, moreover, the rise in A is always less than, and the drop of C always greater than, the rise and fall computed from Stefan's formula. These discrepancies might well be supposed to be connected with the fall in the pitch of B. But the drop of B comes much later and is also much less in amount than the deviations of A. and C.

IV. On discovering that an evident relation obtained between tone B and the proper rate of the fork, we conjectured that the gradual drop in pitch of this tone was due to a change in internal strain of the fork and that this, in turn, was to be ascribed to the action of centrifugal force. To test this conjecture, we substituted magnetic for centrifugal force. A pair of electromagnets were placed close to the outside faces of the fork. We first used a Kœnig fork of 128 vibrations and determined its rate by counting beats with a fork of 128+,—first, when the current was passing through the magnets and, secondly, with an open circuit. Though our results with this method seemed to show a drop in the rate of the fork when the current was on, we did not regard them as entirely satisfactory. The tone of the fork was extremely weak when the magnets were in circuit and died out very rapidly. The longest period over which we were able to count beats was, therefore, only five seconds. To verify our results we used a 50-fork with the graphic method, controlled by a Jacquet chronoscope ticking fifths of a second. Two records without the current gave the rates 48.75 and 49.64 vibrations per second, and one record with the current a rate of 45.40 vibrations. Since, however, the record showed a large variation in the number of vibrations from time-unit to time-unit, we suspected that the Jacquet control was not accurate. Accordingly, we substituted a Kronecker interrupter, vibrating 20 times per second, and went back to our 128 fork. By counting full seconds on the drum record, we were able to get fairly accurate accounts of the vibration-rate. The result was as follows:

Current off (average of three records) $127.55 \pm .35$
Current on (average of two records) $126.42 \pm .22$

From these results it appears that, under the conditions named, a force acting perpendicularly to the faces of a tuning fork will reduce its vibration-rate. We inferred from this fact that the drop in the pitch of tone B was due to centrifugal force acting on the rotating fork. It also becomes evident, from our

experience with forks vibrating in a magnetic field, that outward strain, due to magnetic or centrifugal force (as the case may be), is responsible, at least in part, for the rapid damping of the fork and the consequent early disappearance of the tone produced. It is certainly true that the intensity of the tone dropped at once as soon as the fork was set in rotation.

V. The beats given by tones A or C with standard forks of approximately the same pitch were of a peculiar character. They were not regular beats such as one usually hears with forks of nearly equal pitch. The beats were quite clear and distinct and there can be no doubt that they were present only when the second fork was sounding. The time intervals between the successive bursts of sound, however, were not equal. The most graphic way of expressing their character would be to say that the beats 'dribbled.' Moreover, there was no observable sequence which repeated itself, so far as we could discover. The beats came in no temporal pattern or rhythm, but seemed to be quite arbitrary in their arrangement. Nevertheless, it was sometimes possible to count them and, strangely enough, the count appears to show that the number of beats is indicative of the pitch of the tone. No causal relation that we could discover obtains between these beats and temporary variations in the rate of rotation. The beats from tone B were entirely normal.

Criticism of Exner and Pollak.

In the light of our own experiments, we may venture to make the following criticisms of the earlier experiments of Exner and Pollak. Though these writers regard the rotating fork experiments as crude, and base their conclusions on the telephone and rotating cock experiments, they get essentially the same results by each of the three methods they employ. It would seem, therefore, that our results offer a sufficient basis for a criticism of their conclusions.

(1) The conditions of the experiment were unfavorable for observation. The mode of procedure consisted in starting from a pure tone and gradually increasing the number of phase changes until the observer judged that the tone had disappeared. The experimenters admit that this was a most difficult task, especially in view of the fact that the tone never actually did become inaudible. They refer the continuous sound to the fact that the fork set in vibration the objects to which it was attached. They assert, however, that good results were obtained when the observer limited his attention strictly to the discontinuous sound which was conveyed to him through the ear-tubes.

(2) There was probably a good deal of noise in the course

of the experiment. The fork was electrically driven and was rotated by an electric motor. In the last two forms of experiment the commutator and the rotating stop-cock probably made some noise and the motor was in use in both these latter experiments. The observer was in a room apart from the apparatus and was forced to take indiscriminately all that came to him through the tube. In our own work, where we used a comparatively noiseless apparatus and had it constantly under the observer's eye, we found that a little practice easily enabled us to identify and to abstract from the extraneous noises of the apparatus.

(3) Though Exner and Pollak make a good deal of the importance of using pure tones in their investigation, it is almost impossible that their telephone experiment could have fulfilled this condition. The tones of vibrating plates are notoriously complex, and it is very improbable that the investigators were able to obtain a telephone diaphram which reproduced accurately the pure tone of their fork. They have nothing to say about a test of the telephone in this respect.

(4) Exner and Pollak pay curiously little attention to the pitch of the tone from the rotating fork. Since they were interested only in the point at which the tone disappeared, they assumed that the division of the tone which all experimenters after the Webers noticed was of no importance for them. It certainly is not obvious that this is the case. Moreover, they believe that in the last two forms of their experiment they have succeeded in eliminating this division of the tone. This they assume because in these cases they did not observe any change of pitch. Considering the general disregard of pitch which the rest of the experiments show, we are inclined to think that this is not conclusive against the presence of the phenomenon. Moreover, it is not clear how it was possible to eliminate the division by the means used, unless Stefan is entirely wrong in ascribing it to change of intensity. The latter must certainly have been present. In the last series of experiments, the revolving cock certainly did not cut off the sound instantaneously and must, as it opened and closed, have produced changes of intensity. In fact, it appears that Exner and Pollak have here essentially the conditions which Schaefer and Abraham used to produce their 'interruption tones.'[1] But if we grant that the reversal of the current in the telephone circuit produced a movement of the diaphram approximating Exner's ideal curve, though this seems extremely unlikely, the assumption of a sympathetically vibrating membrane in the

[1] Studien über Unterbrechungstöne, *Arch. f. ges. Phys.*, LXXXVIII, 475 ff.

ear would certainly imply differences of intensity arising from such a mechanism. The whole point of their argument rests on the fact that successive waves act cumulatively upon the resonating fibres and that a change of phase means the introduction of an oppositely directed force and a consequent reduction of the amplitude to zero. The curves which Exner and Pollak reproduce in their article show precisely those changes of amplitude which Stefan presupposes in his theory. Of course, we realize that Exner and Pollak are in no way committed to Stefan's explanation; but they have nothing to say against it, and it is not clear whether they mean to reject it off-hand or whether they believe that they have really produced changes of phase without changes of intensity.

In one respect our results agree perfectly with those of Exner and Pollak. The intensity of the tone decreases very noticeably when the fork is set in rotation. This decrease Exner and Pollak ascribe entirely to the phase changes; as we have seen, it is at least partly due to the centrifugal force acting upon the rotating fork. If the fork rotates slowly, the tone comes in puffs as described above (p. 492). This beating tone, according to Exner and Pollak, gradually lost its tonal character and became a whirring noise. Only two of their observers who were musicians noted a rise in the pitch of the tone. According to our observations, the sound of the moving fork was a very rough tonal complex, which, at the lower rates of rotation, our introspections describe as 'throbbing' or 'beating.' The separate tones of this complex, when brought out clearly with the resonator, were by no means smooth, the lower appearing rougher than the higher. The complex was clearly tonal in its character, however, and showed no tendency to become a 'whirring noise.' In fact, the separate tones became smoother as the rate increased and we are inclined to think that this was the case also with the complex as a whole. We do not believe, either, that the throbbing and beating character of this tone is to be ascribed to the presence of the phase changes. At the low rates of revolution the tones A and C would lie so close together that they would beat or produce a very inharmonious complex. Thus, for example, Helmholtz got beats between two interruption tones where the source of sound was a single fork.[1]

The assumption of Exner and Pollak that the intensity of the tone would approach the limen as the rapidity of rotation increased was verified in their experimental results. For us this result did not appear at all. A rate of three thousand revolutions in the minute left the tones as distinct and, to all

[1] *Sensations of Tone*, Trans. by Ellis, ed. 1895, p. 420.

appearances, as intensive as at the lower rates of rotation.[1] There was a very decided drop in intensity when the fork was set in rotation, but after the fork was once well started there was no appreciable decrease with any rate which we used.

Exner and Pollak found that the tone of their 240 fork disappeared when the fork was rotated six times in the second. There would here be twenty-four phase changes in the second and ten vibrations of the fork between each two successive phase changes. Hence they argue that, for a tone of the intensity they used, ten vibrations are necessary in order to stimulate the nerve endings above the limen of sensibility. The results of all their experiments are essentially the same, though the number of vibrations between phase changes at the point of disappearance differs slightly. Here again it will be seen that our results are entirely at variance with those of Exner and Pollak. Our rate of thirty revolutions in the second gave only 3.2 waves between successive phase changes and our highest rate (fifty per second) gave but 1.92. Yet, as we have said, the clang of the fork was clearly audible and not noticeably diminished in intensity. It is but fair to say, however, that Exner and Pollak make no claim of universality for their figures in this case. The number of waves necessary to excite an audible tone depends entirely on the amplitude of the waves. It is quite possible, therefore, that even less than a single wave might produce an audible tone. The discrepancy is so marked, however, that it seems worth pointing out, for there is no reason to suppose that the tone from our fork differed greatly in intensity from that of the fork used by Exner and Pollak.

In general, our results bear out the experimental data of Stefan. The rotating fork produces not its pure fundamental, but a tonal complex which can be analyzed not into Stefan's two tones, but into *three* tones, one lying very near to the fundamental but falling gradually in pitch as the rate of rotation increases, and two others lying about equidistant above and below the fundamental. The latter tones separate farther and farther as the rate of rotation rises. Whether the pitch of these two tones corresponds exactly to the pitch computed by Stefan's formula, we shall consider in our second paper. We may say, however, by way of anticipation, that there seems to be a constant discrepancy, which suggests the possibility that Stefan's explanation may stand in need of correction. For the theory of Exner and Pollak,—that rapid alternations of phase

[1] This was the highest rate which our apparatus permitted us to reach. We could not maintain it sufficiently long or with sufficient accuracy to get detailed results.

reduce the intensity of the tone below the limen of audibility,—we find no evidence in our experimental results. The complex from the rotating fork retains its tonal character and persists,—after a certain minimal rate is reached,—with undiminished intensity up to the highest rates of rotation which we have been able to employ. We have found, however, in the strain of rotation an alternative explanation for the lesser intensity of the moving fork.

(To be concluded.)

WUNDT'S DOCTRINE OF PSYCHICAL ANALYSIS AND THE PSYCHICAL ELEMENTS, AND SOME RECENT CRITICISM.[1]

I. The Criteria of the Elements and Attributes.

By Edmund H. Hollands.

Like every other science at a certain stage of its development, psychology has begun to examine its fundamental presuppositions. The questions of the nature of analysis, and of the proper definition of the psychical element, are once more in the forefront of discussion. As usual, Wundt is the great storehouse of texts to be assailed or defended, and the appearance of the fifth edition of the *Physiologische Psychologie*, with its extended treatment of feeling-analysis, has made him still more available for this purpose. Two recent articles by Dr. Washburn are particularly noticeable as having made his treatment of these matters the object of severe criticism.[2]

This criticism may be summarily stated under four heads. In the first place, in his account of analysis Wundt has failed clearly to distinguish between the criterion of independent *variability* and that of (actual or possible) independent *existence*. Secondly, while he professedly makes his division between classes of elements on introspective grounds, in his recent works the distinction between sensation and feeling is established by an *epistemological* difference. Thirdly, his ground for excluding clearness from the attributes of sensation is either insufficient, or else would rule out intensity and quality themselves; nor is it evident why pleasantness and unpleasantness, among the directions of feeling, should not themselves be attributes. To these three objections, which are found in the first of the two articles mentioned, the second adds a fourth. Wundt's explanation of the unity of feeling as due to the fact that it is a reaction of apperception, and his consequent definition of the simple feelings, make it impossible to distinguish between simple and complex feelings except by an appeal to their sensational basis.

As these criticisms to a large extent furnish the motive for this paper, it will be well to examine the writer's development

[1] From the Psychological Seminary of Cornell University.
[2] *Philosophical Review*, XI, 445-462; XIV, 21-29.

of them a little more in detail. In doing so, we reproduce the references to Wundt, and, as far as possible, the precise form of the argument.

In the first place, then, Wundt defines an element as "an absolutely simple and unanalyzable conscious process."[1] He intends, therefore, that the process of analysis shall be purely introspective, without physiological or epistemological reference. But what precisely does he mean by the term "unanalyzable?" It may mean that "the bit of conscious content contains no one aspect or part on which attention may be fixed to the neglect of the other aspects." "This would imply that a conscious element could not have attributes," as Prof. Calkins holds, for an attribute *is* precisely an aspect which can be singled out by attention. And the reason why it can be so singled out is, that it is independently variable relatively to its accompanying attribute or attributes. Yet, "it is just this independent variability of two bits of conscious content to which Wundt refers as conditioning their separability by analysis."[2] How, then, can he refuse to carry his abstraction beyond the 'elements' to the 'attributes?' On the other hand, we may call a mental phenomenon analyzable or unanalyzable according as its constituents can or cannot be experienced apart from each other. For example, the pitch and intensity of a tone, while independently variable, cannot be independently experienced; but the partials of a clang can be so experienced. The latter, therefore, are separable in analysis, under this conception of it, while the former are not. Wundt, the implication seems to be, has not clearly distinguished these two meanings of unanalyzable. The first is in accordance with his own words; but it is only the second which will justify him in not carrying the process of analysis beyond the sensations. He should specify whether we are in our analysis using the "method of calling mental phenomena elementary because they are the simplest phenomena that, being independently *variable*, may be attended to separately," or that of "calling them elementary because they are the simplest phenomena, that, as capable of being *experienced apart* from each other, may be attended to separately."[3]

The division between feelings and sensations Wundt attempts to base on introspectively perceived differences, chiefly the well-known list of three given in the *Outlines*. But this basis seems insufficient. The fact that the number of feeling qualities is much greater than that of sensation qualities "is evidently no real basis for an ultimate distinction;" and the unitary connectedness of the feeling system is "no ground for

[1] *Outlines*, 28. [2] *L. c.* [3] *Phil. Rev.*, XI, 448-453.

denying that feelings may constitute a system of sensations." Wundt's real ground for the division "appears to be extra-psychological, and a matter of epistemological reference." He says that psychological analysis yields us "psychical elements of two kinds, corresponding to the two factors contained in immediate experience, the objective contents and the experiencing subject."[1] He also explains the unitariness of the feeling-manifold "by referring to the 'simple, subjective' origin of feelings as compared with the 'manifold, objective' origin of sensations."[2] We find still greater emphasis upon this epistemological ground of distinction in the last edition of the *Physiologische Psychologie*.[3] "It might well be asked whether psychical analysis naturally and inevitably yields this division, or whether Wundt is led to look for two elements because of his desire to make psychological categories out of subject and object."[4] These remarks of the first article, it may be noted, are to some extent qualified by a statement in the second.[5] We are there told that Wundt does not mean by objective and subjective, in this connection, that part of experience which is shared with others and that which is confined to one's self. Indeed we find him explicitly rejecting this meaning.[6]

Clearness, duration and extension Wundt refuses to class with intensity and quality as attributes of sensation. His ground for this refusal is that they depend upon the mental complex in which the sensation is found, clearness as a function of attention, duration and extension as actual products of the complex. "We should then infer that Wundt means by the attribute of a sensation a character that does not spring from the togetherness of sensations, and that is not even influenced in degree by the other surrounding elements." The first of these criteria excludes duration and extension, since "they arise from the togetherness of sensations." But clearness does not so arise. All one can say of it is "that the degree of vividness pertaining to a sensation depends upon its context. A sensation always has some degree of vividness. But, if we refuse to admit under the head of attributes all those characters of sensations which are influenced in their degree or charter by their context, it is a question whether we should not have to rule out quality and intensity."[7] The criticism of the uncertainty as to the precise relation of the feeling-directions to the feeling-qualities, which follows here, we may pass over, as Dr. Washburn in her second article holds that this diffi-

[1] *Outlines*, 28.
[2] *O. c.*, 36.
[3] *Phys. Psych.* (5), I, 345.
[4] *Phil. Rev.*, XI, 454-455.
[5] *Phil. Rev.*, XIV, 28.
[6] *Phys. Psych.* (5), I, 352.
[7] *Phil. Rev.* XI, 457.

culty is sufficiently met by considering these directions to be merely classifications indicating general qualitative likenesses.[1] And even if this were not the case, the reference of the three directions to the three temporal aspects of mental process, on which this criticism is based, has disappeared from Wundt's latest discussions of the matter.

These then are the difficulties of Wundt's treatment of analysis and of the elements in general. But they meet us in an intensified form in the case of feeling-analysis, to which so much space is given in the new edition of the *Physiologische Psychologie*. Here, to account for the unity of feeling, "the old apperceptive theory of feeling is invoked, and we are told that the simplicity of feeling-fusions is due to the simplicity of the underlying physiological process, all feelings being connected with activity of a unitary apperception centre."[2] The question at once arises: "How, then, can introspection, *i. e.*, apperception discover in such unitary feeling-fusions the various elementary feelings?" Wundt's account, when we examine it, makes this difficulty obvious. He defines a simple feeling as "an independently occurring feeling which, while it may enter into combinations with other conscious elements, cannot be divided into other independently existent feelings." But how can one be sure that the components of a presumed simple feeling—for example, the pleasantness and excitement attached to a simple tone—have never occurred separately? Not by direct introspection, for to it the complex and the simple feeling are alike unitary, and besides it is introspection which distinguishes the factors of pleasantness and strain, and all the rest, within the 'simple' feeling. Nor can we appeal to the uniqueness of the sensation to which the feeling is attached, for Wundt argues against feeling being merely feeling-tone of sensation for the precise reason that feelings highly resembling each other may attach to disparate sensations. The only other way open would seem to be to base our distinction of the simple feeling from the complex "on our knowledge that the sensational source of the so-called simple feelings is simple, while the so-called complex feeling is derived from a complex sensational source." At every attempt to make Wundt's account clear, the contradiction between the unity of feeling, as explained by that of apperception, and the analysis of it into indefinite qualitative manifoldness, reappears. The only way to unite these two positions in one system is to refer the manifoldness of feelings to their sensational basis.[3]

It will be noticed that this criticism is founded entirely on

[1] *Cf. l. c.*, XI, 458 with XIV, 22-23.
[2] *Cf. Phys. Psych.* (5), II, 341, 357.
[3] *V.* the article, *Phil. Rev.*, XIV, 21 ff.

passages in the first English edition of the *Outlines* and the fifth German edition of the *Physiologische Psychologie*. The critic says that use is made of "general psychological treatises" and not of "special articles," because "we are not seeking to study what kind of analysis our authorities speculate about, but what kind they use."[1] This explanation seems plausible. Indeed, this was perhaps the only method possible in an article which examines the fundamental principles of Ebbinghaus and of Münsterberg, as well as those of Wundt. Nevertheless, there are few writers less suited to its application than Wundt himself. In spite of his systematic tendency, the phraseology of particular passages as one reads them by themselves is often most annoyingly ambiguous. One's difficulty in such a case can only be removed by a comparison of parallel passages elsewhere, by the interpretation of some one who has studied with him, or, these aids failing one, by a careful consideration of the context. Criticism of the letter of brief isolated passages is always open to grave doubt, and nowhere more so than here. Frequently what is left hazy in one work is found to have been filled out in one immediately preceding, or else receives its completion in that which follows.

The purpose of this paper, accordingly, is twofold. In the first place, it will attempt, by an examination of the various passages bearing directly upon the subject in all of Wundt's published writings, to determine his present theory of analysis and the psychical elements, and the various changes through which it has passed. Such a study, it would seem, will have some value for its own sake, and may assist to some extent in definition of Wundtian terminology. It will, therefore, not confine itself to the four topics suggested by the critic, but include the other aspects of the subject, and especially Wundt's discrimination of psychological analysis from that employed by physical science. But, in the second place, and by the aid of the clearer light which may thus be thrown upon the matter, it will attempt to decide whether, and how far, Dr. Washburn's criticisms are justified.

Those writings of Wundt which bear upon our subject may be most conveniently classified according to the position assigned in them to feeling. On this basis, they fall at once into two periods, one extending from 1862 to 1887, in which feeling is treated as feeling-tone of sensation, and the other from 1889 to the present, in which feeling is made an element. But on closer examination, one is able to distinguish four or even five periods. The *first* is that in which feeling is not an ele-

[1] *L. c.* XI, 446.

ment. It includes the *Beiträge zur Theorie der Sinnesw ahrneh mung*, 1862; the *Vorlesungen über die Menschen- und Thierseele*, 1863; and the first and second editions of the *Physiologische Psychologie*, 1874 and 1880 respectively. The first two of these works may again be distinguished as advocating an epistemological theory, both as to perception and the distinction of feeling from sensation, which the third definitely abandons. The *second* period is one of studies of method. Here we have the *Logik*, 1883; two articles in the first volume of the *Studien*, 1883; and one in the second, 1885. In the *third* period, feeling has become an independent element, but we find no mention of other chief forms of it besides pleasantness and unpleasantness. Here are to be placed the *System der Philosophie*, 1889; an article in the sixth volume of the *Studien*, 1891; the second edition of the *Vorlesungen*, 1892; an article in the tenth volume of the *Studien*, 1894; and the second edition of the *Logik* (*L. der Geisteswissenschaften* II, 2), 1895. A passage in the latter, however, very clearly shows that Wundt no longer regards pleasantness and unpleasantness as adequate classifications of the qualitative variety of feeling. Finally, in the *fourth* period, we have the final definition of the three directions as components of the feeling-manifold, and an increased emphasis upon the importance of feeling. This begins with the first edition of the *Grundriss*, 1896, and includes for our purposes the second edition of the *System der Philosophie*, 1897; the fourth and fifth of the *Grundriss*, 1901 and 1902; and the fifth edition of the *Physiologische Psychologie*, 1902. As will be noticed, the third edition of the *Physiologische Psychologie*, 1887, and the fourth, 1893, have not been included in this list. This is because that portion of them which concerns us here is practically a literal reproduction of the second edition, probably because of the difficulties involved in rewriting a systematic treatise so as to express what was as yet an uncompleted movement in the author's position.

The changes in formal expression as one passes from one of these periods to another are for the most part clear and decisive. This does not mean, of course, that the change in Wundt's theory was equally abrupt. The case is simply that we get only occasional glimpses of the movement of his thought, a hint in an article, perhaps, then finally a formal exposition in some larger work. Public and permanent expression of his views is deferred until he feels that he has some footing in his new position. The special example of this is that to which we have just referred, the long interval from 1880 until 1902, in which, apparently, not a line is added or changed in his most important work to indicate the great change which has taken place in his doctrine of feeling. Not until the whole thing has

been worked out and put in systematic form elsewhere is it incorporated here. Yet, as early as 1883 some passages in the *Studien* show that he had already commenced to move towards his later position.[1] Doubtless a close examination of all his works, including passages which do not concern us here, would reveal many other indications of this gradual shift of emphasis. As it is, however, the division of the material at hand into these periods is perfectly clear and justifiable, and will be found convenient for our purpose.

It will also be convenient, in order to avoid confusion by having too many topics to follow through such a long series of varying expositions, to make a division in our subject-matter. The questions of the nature and method of psychical analysis, of the definition of an element, and of the discrimination of its attributes, are intimately connected, on the one hand; and, on the other, that of the division of elements into the two classes of sensations and feelings, and that of feeling-analysis, involve each other. It is proposed, therefore, in this first section of the paper, to review Wundt's treatment of the first two problems. The second section will discuss his treatment of the other two. What slight repetitions may be involved in this separation of the questions will probably be more than counterbalanced by the advantage of a more ready control of the material.

The first period, as already mentioned, includes the *Beiträge*, the first edition of the *Vorlesungen*, and the first and second editions of the *Physiologische Psychologie*.

In the first two of these works, a peculiar epistemological theory is developed which we shall have occasion to notice more at length later. The pure sensation, the immediate result of the transformation of the physical process into a psychical, is "the not further analyzable element which precedes and conditions perception."[2] It is so received by Wundt, evidently, as an immediate *datum* of experience, and the conditions of analysis are not discussed. The perceptional process itself is described as one of unconscious judgment, a series of inferences (*Schlüsse*), which again are based on 'primitive judgments' which have material but not psychical content,—that is, are the sources of absolutely given distinctions in sense-experience, physically but not psychologically analyzable.[3] The 'inferences' are the sensations corresponding to these distinctions. They have intensity and quality as attributes, the first distinguishing the sensations of like kind, and the second those of different kinds. It is accordingly our task to search for the

[1] *Studien*, I, 5-6, 344 ff.
[2] *Beiträge*, 424.
[3] *Beiträge*, 437, etc. *Vorlesungen*, I, 56-58.

distinct qualities of sensation, which we can regard as simple and pure, being disparate.[1] We find that each such elementary sensation corresponds to a definite physical process. Physical process and psychical element may therefore be regarded as only differing expressions for an identical content.[2]

It is apparent that in these early works Wundt's psychology has not as yet disentangled itself from his metaphysics and epistemology. The movement of his argument is from sensations as effects to physical processes as causes, rather than from the processes to their effects in sensation. But in spite of the epistemological and teleological coloring, there is an implicit appeal to introspection, the structural intention is obvious, and the two attributes of sensation are indicated by a criterion which is retained later.

In the first edition of the *Physiologische Psychologie*, eleven years later, we find a decided advance. The 'unconscious judgment' theory has entirely disappeared. While the pure sensations are abstractions, never existing as such in consciousness, the psychological facts brought to light by the examination and analysis of representations—for example, of visual ideas—force us to presuppose their existence, and to hold that representations arise from a synthesis of them.[3] In other words, the elementary psychical phenomena are discovered by the experimental control and investigation of the physical processes with which they are connected.[4] By such control they may be separated and experienced in varying contexts. The idea is a connection of a plurality of sensations, in an arrangement either spatial or temporal; and these sensations are the primitive and simple contents of consciousness.[5] As such man finds them in himself. Abstracted from the spatial, temporal, and other relations to the rest of mental content, the sensation has only the attributes of *intensity* and *quality*. We can picture its existence to ourselves by imagining a statue like that of Condillac beginning to live.[6]

It is true that feeling-tone is also a constituent of the sensation. But it is not, like the intensity and the quality, an original and independent constituent of consciousness. In the first place, it is determined by the intensity and quality of the sensation;[7] in the second, the feeling-tone disappears, when we consider the sensation by itself, without reference to the consciousness into which it enters, while from intensity and quality we cannot abstract without destroying the sensation.[8]

As for the original constituents of the pure sensation, inten-

[1] *Vorlesungen*, I, 138-140.
[2] *O. c.*, I, 187-188, 200.
[3] *Phys. Psych.* (1), 711-712, 273.
[4] *O. c.*, 5.
[5] *O. c.*, 464.
[6] *O. c.*, 473.
[7] *O. c.*, 5.
[8] *O. c.*, 273, 426.

sity and quality, we distinguish them only because they are *independently variable* constituents of every sensation we experience. This independent variability rests on the fact that intensity depends on amplitude or *strength* of the stimulus vibrations, and quality on the *form* of these vibrations, a relation which is evident in simple tones.[1] In other words, we are able, in some cases at least, physically to control this independent variation, and so clearly to exhibit it to introspection. Wundt also defines quality here as "that constituent which remains, when we think away intensity."[2] This implies another standard of discrimination between attributes,—that of possible abstraction.

This last standard is, however, rejected by the *second* edition. There we are told that we canot think of quality and intensity as separate; every quality must have a certain intensity, every intensity refer to some quality.[3] The criterion which helped to rule out feeling-tone as an attribute in the first edition—that, namely, that it is dependent on intensity and quality—also seems to be tacitly rejected. Wundt says that while feeling-tone, intensity, and quality never appear separately, their separation is an abstraction made necessary by the change in the sensations.[4] This is obviously the same criterion as 'independent variability' in the first edition. Apparently, then, as far as the explicit treatment here goes, feeling-tone might be on the same footing with quality and intensity as an attribute, were it not perhaps that we have sensations free from feeling-tone,[5] while all sensations have quality and intensity. The second criterion which excluded it before is, however, retained, for we are told that spatial relation, sometimes made a fourth attribute, is not an attribute of sensations as such, but pertains to their union in ideas. The remark of the *Vorlesungen*, that differing sensations are distinguished by their quality, and similar by their differing intensity, is also repeated, and it is further stated that "it is an immediate fact of inner experience that every sensation has a certain intensity" by virtue of which such comparisons can be made.[6] Psychological analysis in general is defended on the ground that such an abstraction is as necessary for the examination of mental complexes, as is the similar analysis of chemistry to establish the laws of chemical combination. Unlike chemistry, however, psychology can never experience its elements in actual isolation from the complexes, and hence disputes as to which constituents are really unanalyzable are to some extent possible.[7]

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[1] *O. c.*, 280-282.
[2] *O. c.*, 315.
[3] *Phys. Psych.* (2), I, 272.
[4] *L. c.*
[5] *O. c.*, I, 272, 465.
[6] *O. c.*, I, 272, 321.
[7] *O. c.*, I, 271.

We may then summarize our net result from this first period as follows. *Analysis* is justified in psychology, as in any other science, by the requirements imposed by the investigation of complex phenomena. Its special difficulty here is the fact that its elements never appear in entire isolation. Its method is introspection under experimental control of the conditions, and therefore involves the postulate of a functional connection of mental event with physical stimulus. The fact that marks off the *element* is its separability. While no breach can be made in it, yet it can, under experimental variation of the conditions, be experienced in different mental contexts. That this is Wundt's meaning is perfectly clear, both from his account of analysis, and from his insistence upon independent variability as the test of an *attribute*. There is also a passing reference to direct introspection as confirming the title of the elements—"man finds them in himself."[1] This, however, does not seem to be meant very seriously.

Of criteria for the *attributes* we find four. In the first place, the element is structurally distinguished by quality and intensity. The former is the aspect marking it off from unlike elements, the latter that which distinguishes it from like elements. These two attributes, therefore, and no more, are essential to make the element, as it were, self-contained. In the second place, every sensation has these attributes, and they are inseparable both from it and from each other. Further, these attributes attach to the element itself, and do not depend on its relation to the complex of which it forms a part. Finally, as distinguishing them from each other, we find that they are independently variable and can therefore be attended to separately. As this independence in variation has its physical correlate and cause in the two aspects of the stimulus movement, it can be experimentally controlled and demonstrated.

So far as this carries us, then, Wundt's meaning for 'unanalyzable' would seem to be clearer, on a fair examination, and his grounds for distinguishing the attributes broader, than the criticism with which we began would lead us to suppose. But we must not anticipate conclusions. Let us go on to examine the work of the second period.

This is chiefly interesting as a more detailed and logical account of the method of psychological analysis. Analysis is of three kinds, descriptive, causal, and logical. Only the first two are of use in psychology. In some sciences, such as physiology, descriptive analysis, or the mere separation of an object or phenomenon into its distinguishable elements, forms a necessary and separate preliminary stage. In psychology,

[1] *Phys. Psych.* (1), 273.

however, descriptive and causal analysis are practically coincident. Like physics, it begins with the simplest facts, the causal explanation of which is immediately evident. That of the more complicated phenomena is then arrived at by a synthetic procedure. Causal analysis is distinguished by two factors, the *isolating* of the elements from their coexistents, and the *variation* of them by changing the conditions of their occurrence, in the analytical form of the *experiment*.[1]

These principles are most readily examined with reference to the analysis of perceptual ideas. The task of analysis here is twofold; it has to discover the simple sensations, and also to establish the laws of their combination.[2] These two things usually coincide, since the result of the necessary variation of experimental conditions in the course of the analysis will at the same time determine the laws of combination. The discovery of elements may be *direct*, by synthetic reconstruction of the ideas from them, or *indirect*, by experimental analysis of the idea. The synthetic is the preferable method, but as it presupposes a more complete control of the elements of the idea, implying their appearance in isolation, and their combinability at pleasure, it is possible to apply it exactly only in the case of tonal ideas. Its main use is therefore as an auxiliary method to confirm or guide the indirect method. This latter may be either without external aids, or by the experimental control of the perception under analysis. These two forms of it Wundt calls the simple *analytic* method and the *variation* method. There is, however, no strict distinction between the two. An example of the analytic method is the subjective analysis of a clang. In the case of spatial ideas it is the only form of analysis applicable, because every element of such an idea is itself spatial, and our analysis can only determine minimal magnitudes. In the variation method the variation we introduce may be in the stimulus, in the subject, or in both at the same time.[3]

Some cautions to the psychologist may be added. It is true that the qualities and laws of the sensations have been established by the psychophysical method, and that this method is practically the beginning of psychology.[4] But it must be remembered that the reference in it to external stimuli is due only to the general character of experimental method in psychology, and that the real objects of the investigation are the sensations as psychical states.[5] On the other hand, the logical explanation of a process must not be confused with the process itself, as is so often the case in popular thought;

[1] *Logik* (1), II, 3-5.
[2] *Cf. o. c.*, II, 487.
[3] *Studien*, I, 18-24.
[4] *Cf. Logik* (1), II, 485.
[5] *Studien*, I, 5-6.

and psychological analysis must never regard the products of its abstraction as independent processes.[1] The fact is, that simple sensations are never given us in immediate introspection, but are defined because of the requirements of our analysis. It does not follow, however, because they are thus in a sense artifacts, that they are 'unconscious' processes; for mere uncontrolled introspection can no more replace psychological analysis than outward examination of a body can replace its physical or chemical analysis.[2]

Comment on this discussion is not necessary. What is important in it for our purpose is its caution against invoking physiology on the one hand, or epistemology on the other, to interfere in the task of psychology; and its equal emphasis upon introspection and experimental control. The criterion of the element is still its separability from its context; the process of analysis is one of elimination and reconstruction.

It has already been said that the third edition of the *Physiologische Psychologie* adds nothing to the second. It may, however, be mentioned that in it, apparently for the first time, we find a clear statement of the principle of psychic synthesis as resulting in a new product which possesses qualities not present in its elements. This comes up in connection with the spatial idea, and Wundt adds that the sensational elements of this are discoverable only by an analysis which infers them from the changes which the complex undergoes under differing physiological conditions.[3]

The third period begins with the *System der Philosophie.* Here we find four reasons for considering that feelings are independent elements. (1) Feeling "is not objectified," as sensation is. (2) Experience as a whole has an objective and a subjective side; feelings are the elements of the latter, sensations of the former. (3) The feeling attached to a sensation does not vary in like measure with its intensity or its quality, and is not, therefore, like them an attribute of the sensation. (4) While feeling is always attached to *some* sensational or ideational content, the connection is not invariable; the same content may appear without the feeling, or the same feeling may attach itself to a different content.[4] It is the last two of these reasons which concern us at present. That for not considering feeling an attribute of sensation is, evidently, equivalent to the fact that its functional relation is not with its sensational basis only. That is, we have an implicit use of the criterion for an attribute which has already been mentioned, that it does not depend on the relation of the element to the

[1] *O. c.*, 344, 349-350.
[2] *Studien*, II, 299-301.
[3] *Phys. Psych.* (3), II, 33.
[4] *Syst. d. Phil.* (1), 386-387.

complex of which it forms a part. The last reason establishes the right of feelings to the place of elements by the normal criterion. They can be separately experienced in varying contexts. Implicit, of course, is the further but as yet unstated premise that the simple feeling cannot itself be experimentally decomposed into parts which can be thus separately experienced.

The important article *Zur Lehre von den Gemüthsbewegungen*[1] does not bear on the present portion of our subject. Nor is there anything new in the second edition of the *Vorlesungen*,[2] except a clearer statement of one of the functions of the experiment not dwelt upon before. 'Pure' introspection cannot directly observe conscious processes during their course, but only their after-effects in memory. One must therefore attempt to remove the disturbing influence of accompanying observation upon conscious processes by objective control of the physical processes with which they are functionally connected.[3]

The fourth edition of the *Physiologische Psychologie* may also be passed over, as has been explained. This brings us to two important discussions of analytic method, which are to be found in an article in the tenth volume of the *Studien*,[4] and in the second edition of the *Logik*.

In the former, the method of psychology is distinguished from that of epistemology. In both disciplines the analysis of objective perception must start from the given external object. But their method is by no means the same. Epistemology, if it is not to become a "fruitless subjectivism," must, like natural science, presuppose the *objective* nature of the object and all its properties, and then gradually correct, by the aid of suitable hypotheses, the contradictions involved in this assumption. The interest of psychology, however, attaches to the *subjective* formation of the idea of the object. It therefore assumes that the object and all its properties is throughout a subjective process, given immediately in sensation. Contradictions are involved in this assumption also, and these, too, are removed by the aid of hypotheses. Certain elements of the object will prove on examination not to be given immediately, and this necessitates our finding the subjective conditions which have produced them. Every such contradiction has, therefore, a double result. A psychic formation at first regarded as simple is found to be composite, and this implies a psychic process which is the cause of this composition. This defines the real field of psychology, which the materialistic psychologists fail

[1] *Studien*, VI, 337 ff.
[2] *Cf. Vorlesungen* (2), 14-17, 68.
[3] *O. c.*, 13-14.
[4] *Ueber psychische Causalität*, etc. *Studien*, X (1891).

to enter because of their misuse of the epistemological assumption.[1]

The discussion in the *Logik* is along the same lines, but the analysis of psychology is contrasted with that of physical science. The differences found are chiefly two. Physical science abstracts from certain *attributes* of the object of its analysis, while psychological analysis isolates *partial contents* of consciousness. These partial contents psychology retains as independent *processes;* but mechanics changes relative into *absolute* attributes. This difference is possible because physical science refers its abstract qualities to a material substrate. Psychology, however, must accept conscious content as a datum which it can analyze into parts, but never reduce to a homogeneous substrate. The chief example of a mistaken attempt at such a reduction is the intellectualistic psychology, which is based partly on the availability of logical technique, and partly on the psychological fallacy of a substitution of the observer's reflections on the mental processes for the processes themselves. It takes the part for the whole, the means of investigation for the thing investigated. To avoid such errors it is essential to remember that our conscious life is one interconnected process.[2] The more detailed account of the standpoints of Materialism, Intellectualism, and Voluntarism which follows need not detain us now.[3]

Of more immediate interest for our present purpose is the account here given of the method and criteria of psychological analysis. It follows, we are told, the maxim of *independent variability*. (What can vary independently of the rest of the content, or remains constant while the rest of the content varies, is an independent element.[4]) This axiom needs further specification, which we find in a later discussion of *elementary* psychical analysis.[5] Psychical elements must fulfill the condition of not vanishing in the isolating abstraction applied to the conscious process. (Every element is to be considered simple which, in the first place, admits of no separation under experimental variation of the conditions; and, in the second, can be thought of as invariable while the other introspective contents change.) The first criterion excludes the forms of space and time; the second excludes these and also other qualitative contents dependent on the presence of many elements. Only pure sensations meet both these conditions, for feelings vanish when the sensation is 'thought away.'[6] Sensations and ideas

[1] *O. c.*, 82-84.
[2] *Logik* (2), (*L. der Geisteswissenschaften*) II, 2, 60-63.
[3] *Cf. o. c.*, 153-168.
[4] *O. c.*, 60.
[5] *O. c.*, 196 ff.
[6] *O. c.*, 198.

are therefore the only objects of elementary psychical analysis, which may be either qualitative or quantitative.[1] But it does not follow that there are no simple feelings. The idea that all subjectively unanalyzable constituents of consciousness must also be thinkable in isolation is a mere dogmatic prejudice. There are simple unanalyzable feelings, but they cannot be isolated, like the sensations, because they have not an objective reference. The methods of analysis employed for feeling differ, for this reason, from those used for sensation.[2] Simple feelings are then not *independent* elements.[3] Yet they are, of course, elements in the psychological sense, being unanalyzable.

To make these rather puzzling passages clear, it is necessary to anticipate, and to refer for a moment to the fifth edition of the *Physiologische Psychologie*. This mentions two conditions for analysis, an objective and a subjective, as Wundt says: the changing relations of the mental constituents, and the isolating and distinguishing effect of attention.[4] But this second subjective condition is not mentioned as a condition of feeling-analysis. The criterion for simplicity of a feeling is, that it cannot be separated into simpler feelings appearing independently for themselves.[5] Actual independent existence is, therefore, the mark of a simple feeling; its appearance for itself, as not further divisible under any change of conditions, and standing in varying relations to the other elements of mental process. This appearance of only the objective condition of analysis in the case of feelings is exactly parallel to what we find in the discussion of the *Logik*, and it is apparent that "thinking of as invariable while the other conscious contents change" means isolation as an object of attention.

This being granted, it would seem that the *Logik* points out three criteria for an element. It must be independently variable; it must admit of no separation within itself under experimental change of the conditions; and it must be capable of isolation as an object of attention. Only the first two, however, are the criteria of the unanalyzable element as such; the third applies only to sensations. But the independent variability is not that which we found in earlier works as distinguishing the two attributes from each other. It is here defined as one in which *all the rest* of conscious content may change. That is, it is the old criterion of being separately experienced in varying connections and contexts; and to it is added the further criterion of non-decomposability. The *Logik* then simply explicates the maxim and criteria of analysis which were ap-

[1] *O. c.*, 200.
[2] *O. c.*, 199.
[3] *O. c.*, 198.
[4] *Phys. Psych.* (5), I, 339-341.
[5] *Phys. Psych.* (5), II, 305.

plied in the *System der Philosophie*. These two criteria cannot, of course, be separated, and on looking back to the first edition of the *Logik* we see that they correspond roughly to what are there called the simple analytic method and the method of variation. The first method introspectively establishes the independence of the element as a part of psychic experience; the second assures us that it is not further decomposable under any alteration in the conditions.

Let us recall that the reprint in unaltered form (so far as our subject goes) of the second edition of the *Physiologische Psychologie* in a third and a fourth carried through the second and third periods the same principles which we found set forth in the first. This being the case, we see that the writings of these two periods have only further explicated and developed those principles. The introspective and specific character of psychological analysis has been emphasized, and the importance and function of the experiment has been more particularly explained. The criterion of non-decomposability, implicit from the first, has been explicitly stated as the necessary completion of the original, that of separability in experience, or, as it is now named, "independent variability." Finally, while the elementary attributes have not come up for further discussion, we found that use was made in the *System der Philosophie* of the criterion of independence on the relation of the element to the complex; and the reference to their independence in variation relative to each other is renewed in the second edition of the *Vorlesungen*.[1]

At the opening of the fourth and last period, we find the discussion of analysis and the elements in the first edition of the *Grundriss der Psychologie* rather confusing. Abstraction is necessary in psychological analysis,[2] and therefore simple feelings are abstracted from their accompanying sensations.[3] But, on the other hand, feelings cannot be abstracted from sensations, and are therefore never pure.[4] Obviously 'abstraction' cannot have the same meaning in these two connections. Apparently the abstraction which assists analysis involves making the element the object of attention to the disregard of remaining conscious content, while that which is not possible for feeling involves the actual *isolation* of the object of attention. Thus, for example, we might conceivably find conditions—say in the dark room of a laboratory—in which some single sensation in the indifference-zone of feeling might be, relatively speaking, the whole content of consciousness. But we cannot

[1] *Vorlesungen* (2), 16-17.
[2] *Outlines* (1st English ed.), 28.
[3] *O. c.*, 29, 76.
[4] *O. c.*, 37.

conceive the possibility of experiencing a feeling in isolation from *any* sensational substrate whatever.

If this be granted, all we have left in reference to analysis is the admission that the consideration of the element apart from its connection is itself an abstraction,[1] and the explanation that analysis is made possible by the changing relations of conscious contents.[2] Neither of these principles is new, and they must be interpreted by the longer expositions of analysis which have been already reviewed.

Nor do we find here anything new concerning the attributes.[3] What is said, however, is based on the use of the two most important of the four criteria for them; that is, that they are the structurally necessary aspects of the element, and aspects which are free from functional dependence on the rest of conscious content.

The second edition of the *System der Philosophie* contains no new matter relevant to our present subject, except a renewal of the warning against making use in psychology of those hypothetical concepts of substrate which are necessary in physical science.[4] The fourth and fifth editions of the *Grundriss* are exact reproductions of the first in the sections we have examined.

The justification of psychological analysis which Wundt gives in the fifth edition of the *Physiologische Psychologie* is in much the same terms as the explanations which he had already given in the *Studien* and the *Logik*.[5] It is unnecessary, therefore, to pause to review it. Yet it is immediately interesting to us, for it shows that Wundt retains his structural position. The elements are analyzed out, it is true, only in order to discover the laws of psychic process; but for that purpose their previous determination is essentially necessary.

The discussion of the method of analysis adds little to our previous conclusions. Its two conditions, objective and subjective, have been already stated. As the elements analyze themselves out, as it were, by their presence in the same form in different combinations, they are in one sense purely empirical. On the other hand, they never exist in isolation and fixity as we conceive them. That is, they are abstract as to their isolation; but they are contents of immediate concrete experience as to their attributes, while the elements of physical science are throughout the products of conceptual abstraction.[6] While sensations, however, can be abstracted from feelings, feelings cannot be abstracted from sensations.[2] Accordingly, as

[1] *O. c.*, 29, 38, 76.
[2] *O. c.*, 28.
[3] *Cf. o. c.*, 30-32, 78.
[4] *Syst. d. Phil.* (2), 361.
[5] *Phys. Psych.* (5), I, 343-344, 357-359.
[6] *O. c.*, I, 339-342; II, 308; III, 321.
[7] *O. c.*, I, 352.

we have already seen, Wundt does not mention the isolating effect of attention as a condition of feeling-analysis. Simple feelings he defines as those which cannot be separated into simpler feelings appearing independently for themselves.[1]

This definition we have already commented upon, and it has been noticed that Wundt means here by the isolating effect of attention what he has meant in some previous discussions by thinking of an element in abstraction from other conscious contents, or as invariable while they change. All that this treatment then adds to preceding explanations is this more precise description of an auxiliary factor in the analysis of sensations. The objective condition, which is the general condition of both forms of analysis, corresponds to what we have met before as the criterion of the element, its relatively self-sufficient existence in varying relations. It is not stated as clearly as could be desired, but it must be interpreted in accordance with all of Wundt's previous teaching.

What is said concerning the attributes repeats the statements of preceding editions,[2] except that the recent controversy concerning clearness is faced. All sensations have intensity. But Weber's law does not apply to the sensations in themselves, but to their apperception, without which the quantitative estimate would not be made.[3] We find that the physiological view (*e. g.* of Ebbinghaus) regards the *having* of sensations and the *comparing* of them as one and the same thing, while the psychological view decisively distinguishes these experiences. This difference arises because the physiological interpretation avoids psychological analysis. On the other hand, it is an unjustifiable overemphasis of the difference between the physiological and psychological points of view to regard intensity as a physical magnitude, which has been mistakenly introduced into psychology, and therefore to call it a particular direction of quality, or to substitute for it the notion of clearness. The specific character of sensation-intensity, and its occasional functional interdependence with quality, does not prevent its being essentially different from quality. This difference is shown by the fact that we compare as immediately analogous the intensity-changes of the various sense-modalities. And clearness and intensity of sensation are by no means the same. The clear sensation may have slight intensity, and *vice versa*, and the limens for attention and for sensation are found by experiment to be distinct.[4]

Wundt's language here shows that he accepts the position that the intensities of any sense-modality are in a sense as

[1] *O. c.*, II, 305.
[2] *Cf.*, *e. g.*, *o. c.*, I, 466.
[3] *O. c.*, I, 541.
[4] *O. c.*, I, 551.

specific to it as its qualities. And his final argument against the identification of clearness and intensity involves a new reason, not heretofore stated, and not made explicit here, for not accepting clearness as an attribute. This is, that since the limen for attention and that for sensation are distinct, we have some sensations without any clearness-value.

It is not necessary to sum up the discussions of the fourth period. It adds nothing to those preceding except further exemplification of working-principles, and the statement of the place of attention in analytic method.

Looking over the whole course of Wundt's literary activity, then, it would seem that the principles of analysis which we were able to find in the work of the first period have remained substantially unchanged. The method of analysis, the functions of the experiment, and the distinction of psychological procedure from that of logic on the one hand, and that of physics and physiology on the other, have been far more precisely set forth. But the fundamental principles have remained the same, and, indeed, because of the natural diversion of attention as the field enlarged, are perhaps not so clear in some respects in these later works as in the earlier.

This being true, it would seem that that part of Dr. Washburn's criticism with which we are at present occupied falls to the ground. Wundt's criterion for the elements, in the light of his practice and of all his writing, is precisely that they are "the simplest phenomena that, as capable of being experienced apart from each other, may be attended to separately,"[1] provided we qualify this 'apart from' and 'attended to' so that they do not involve isolation. As we have already stated it, "the fact that marks off the element is its separability, the fact (that is) that while no breach can be made in it, yet it can be experienced in different mental contexts." This is sufficient to distinguish the element from its attributes. The pitch of a simple tone is indeed itself simple; but it cannot move into an entirely different context, because it cannot be experienced without *some* tonal intensity. The simple tone itself, however, may be divorced in experience from all other sensations of sound.

It must be admitted that the passages on this matter in the *Grundriss* and the fifth edition of the *Physiologische Psychologie* have a certain ambiguity, if taken by themselves. The possibility of misconception had probably not occurred to Wundt, and he failed to make his statements sufficiently precise. But his meaning is clear if one considers the use he makes of his

[1] *Ut ante, Phil. Rev.*, XI, 453.

principles in these same works, and still more so when one calls his earlier works to aid.

As for the attributes, we have found that Wundt makes use of four criteria to distinguish them, instead of merely the one to which the critic refers. One of these is systematic; the two attributes of quality and intensity are necessary and also sufficient to make the element self-contained as structural. Another, that of independent variability, allows us to hold the two attributes apart from each other. Finally, as immediate marks of the attributes, we have the introspective fact that all elements have these attributes as inseparable peculiarities, and that they are independent of the relation of the element to the complex. Wundt, as has been seen, would hold that clearness is ruled out as an attribute under both of these last two heads. The sensation comes above the limen before clearness attaches to it.

It would certainly seem, therefore, that the critic has, in this question of the attributes especially, relied too much on the wording of one or two isolated passages. It is true that all four of these reasons for selecting quality and intensity as the elementary attributes are not stated with equal clearness by Wundt. But they are those which he uses,—and that is the important point, as Dr. Washburn herself suggests.

A CASE OF SYMBOLISTIC WRITING WITH SENILE DELUSIONS.[1]

By ARNOLD L. GESELL, Fellow in Clark University.

The symbolistic writing, which we are about to describe, is instructive because it furnishes in more than usual detail some picture of the mental processes which may dominate a deluded mind. In the present instance the writing is a daily practice and constitutes a tangible, progressive record, which, although it cannot be interpreted in its entirety, is replete with interest and suggestion.

The executor of the "picturesque writing," as he prefers to call it, was born in New England in 1837. He is a rather healthy looking man, above medium height, without marked signs of age or decrepitude; no tremor in his hands; somewhat restless, piercing eyes; an active, eager gait. He enjoyed a common school education which he has supplemented by not a little reading in newspapers and books of a religious nature. He knows his bible well, has a good memory for recent as well as past events, a good vocabulary and a fluent speech. For most of his life he has been a steady, industrious laboring man of reticent disposition. His present occupation, so far as he has any, is vending a liniment, the formula for which he claims to have received from the Lord. Recently he has taken advantage of the curiosity which his extraordinary writing excites and sells specimens of it "to the boys," at a price.

Only a few facts of heredity are demonstrable. The father of J. D. was a stern, self-determined, powerful preacher of the gospel, who received a solemn "call" to enter the pulpit on the occasion of a thunderstorm through which the voice of the Lord addressed him. This dramatic event probably made a deep impression on the son, who now speaks with great reverence of his "sainted father," calls him the Perfect Man, and often alludes to him in his picturesque writing.—"My father never read a sermon. He preached and looked upon his hearers." "The Holy Bible, God, and Common Sense inspired my sainted father to learn his sermons while at work in the field." The mother is also reported to have been a strongly religious minded woman.

J. D. himself relates how his grandmother used to impress him, as a child, with the horrors of hell fire, how she used to show him the devil, peeping through the window, etc. He

[1] *Author's Note.*—I wish to acknowledge my indebtedness to President Hall for suggesting the study and for his kindly interest in the preparation of the paper.

tells a long and tragic story of a childhood dispute he had with his father on the subject of infant damnation.—Why should his little unbaptized cousin be doomed to roast in an eternal hell? "When the wind blew about the eaves they told me it was my cousin moaning." He relates: "I began to hate God. I never knew before, that God made hell. 'What a mean fellow God is,' I thought; I rolled up my fists at him, ready to knock him down if I saw him." In one of these precocious debates, he says he kicked the bible across the floor. Making some allowance here, for retrospective falsification, the facts still point to an intense religious environment superimposed upon a predisposing hereditary basis.

A brief history of the case will show that it passed only in a most general way through the characteristic stages of true paranoia. Throughout his life J. D. was inclined to be gloomy and brooding by spells, and to fall without serious provocation into moods of obstinacy during which he would not speak for days at a time to wife or brother. Sometimes he showed a grim determination in his manner of work, carrying on his occupation with a semi-fanatic disregard for fatigue or injuries, and taking inward pride in the triumph of his will. Two and a half years ago, he surprised his friends by an unwonted effusiveness. He bubbled over with expressions of his exalted sense of well being, declaring he was a young man again and had never felt better in his life. He was extravagantly courteous, generous, hospitable. When some schoolboys pelted his weather-beaten umbrella, he took it as huge fun, arguing that they were not to be blamed,—but more of this umbrella later. Only once did he have a glint of suspicion about his mental deterioration; but his anxiety was very brief, for he believed that defective memory was a necessary accompaniment of insanity, and consoled himself with the thought that he could still repeat a sermon after having heard it. This mistaken notion as to the nature of insanity may have hastened an acceptance of the delusions that were emerging in his consciousness.

These delusions were from the first almost exclusively of an expansive nature. The ideas of persecution which are so characteristic in the development of paranoia, took only a very mild form, and were always offset by ideas of grandeur; thus, immediately after attributing poisonous qualities to the oil with which he came into contact in the factory, he received from the Lord a remedy to cure the evil effects; and when the Y. M. C. A. and the Church thwarted him in his desire to preach he declared that he was misunderstood, even as Christ was misunderstood, and proceeded to call down grandiose, religiose imprecations upon them. He claims that his present omniscience and grand prerogative came to him suddenly, in

something like a glorious transfiguration during which he broke out into song, singing as never he had before. But as a matter of fact, the onset of the delusions was gradual, and their development can be roughly traced. Simultaneously with the feeling of elation and well being already mentioned, he evinced an interest in the work of the "holy healers" then being reported in the newspapers. He declared their miracles were easy and tried his hand at healing one of his friends, by making passes over him, etc. He also began to sit up nights and tried the strength of his will on his wife to prove that he could rouse her from sleep at any hour by the power of his mind. Later he gave way to less self-centered ideas and became the passive instrument of a series of "wonderful manifestations," which took place after midnight. These manifestations consisted of jerkings of the arms and body; they were ascribed to an outside influence, variously interpreted as emanating from his "sainted father" or the Heavenly Lord.

After this experience the developments are more rapid. He talks of going out into the world to preach. The delusions grow to be more and more compelling; at first only of the nature of incidental, nightly adventures, they finally become all engrossing. Kraft-Ebbing's description of *paranoia-religiosa* applies: "Sublime feelings of the suffusion of divine spirit through a sinful body rise into consciousness, and sweep him from all earthly interests and cares." So J. D. gives up his employment, ceases to pay his rent, no longer brings provisions to the house, lets his insurance run out, and when his wife writes to him about the wood-pile he replies with grandiose allusions to his heavenly mission: 'The Lord is running him;' Providence will provide. With time the vague manifestations mentioned above take on a definite form and are filled with a definite content, determined by his former religious brooding. He feels himself called upon to denounce the belief in hell and water baptism. The aimless jerkings of his arms and hands evolve into the controlled movements of a pen upon paper, and for hours at a time during his nightly vigils he writes down what the Lord, his sainted father, Nature, or the Creative Influence dictate to him. He claims to have all things revealed to him 'from 6,000 years before Adam to the final crash of judgment.' He becomes the self-styled "Christian Naturalist," "The Inspired J. D.," "The Cleansed Leper."

We now come to a consideration of the most unique feature of this case—the writing, of which examples are shown in the accompanying illustrations. The inspired executor of this strange script has, since January, 1904, filled some ten volumes, making a total of about 1,000 pages, to say nothing of

numerous letters and other individual documents. One of the volumes before me contains 90 pages, and according to the dates, it took him a fortnight to complete it. At first the books were sacred property which no human eye was privileged to behold, for they contained, as he declared, the revealed groundwork for future sermons. One bundle of books carefully wrapped in paper bears the following label: "For Curiosity. Not for admiration; but for a better purpose. Sacred forever. Don't open." But this injunction is now antiquated; for the author of the volumes takes pleasure in displaying them whenever he has an opportunity. He is somewhat embarrassed by his frequent inability to read what he has written in the past; but saves himself by insisting that the books are of private and personal importance only; they will be bequeathed to some archive for the curious wonderment of posterity, not its enlightenment. The author himself does not refer to the back volumes. It would be useless, he argues; he knows them all. He writes, he explains, as a matter of self education, to get into rapport with Nature, the Creative Influence, and in some mysterious compliance to the scriptural injunction, "Whatsoever thy hand findeth to do, do it with thy might." "It is," he says, "to educate myself through my hands."

The entries from day to day have no connection with each other, and are limited to a rather definite range of ideas. They are largely in the nature of aphorisms and special commandments, both original and garbled. Following is a selection of examples largely drawn from three volumes written during the early part of the present year:

God—Nature—Love. No formality here. Midnight revelations. Come and see, just as you be. (Title page.)

God, Nature, my Saviour, Angels, Reason, Common-sense, and the Holy Bible inspire me.

Superstition makes men fear.

Why has a man a right to make law more unjust than God's law?

Faith without works avails nothing.

The mystery of life is solved: Harmony, Holy Bible, Nature, Reason.

"Look up" elevates. "Lie down" rests. "Bow down" degrades.

A man must obey Nature's laws in order to be happy.

God has winked at man's ignorance too long already. Awake thou that sleepest and Christ will give thee light.

I will fight until death in defense of God's Holy Bible.

I am will. Fight for God and Humanity forever.

Friends reproach me. I care not. God is with me.

In the name of God and Reason teach what Christ taught.

Let woman enlist with a will equal rights.

The doctrine of eternal punishment is too fiendish to be allowed.

We learn from nature, truth; from man, falsehood.

My meat is to do the will of Him that sent me.

I fully understand what my mission is and the influence that impels me on.

My Saviour and angels are waiting for me; now tell me what can I fear?

God is Nature. Nature inspired Moses to write the law.

A correct concept of God and duty is not taught in any Christian pulpit to-day.

O God, open the eyes of stupid pastors.

I am agent for a . . . enterprise, demonstrator of what Christ meant.

Denied by the platform . . . Try the press. I will.

Sixty years of pent up force caused indescribable misery all from being taught an accursed doctrine.

Teach woman to maintain dignity of purpose and to insist upon her right to protect herself and offspring.

Pure hearts see God, Nature, Harmony, Heaven.

Ignorance creates criminality and crime.

If we are living in harmony with Nature, we need no baptism.

Baptism is mockery if our lives are impure. If pure, we need no baptism.

Progress in the thought to-day: Reason, common sense, faithful service, pure heart, means harmony, Heaven.

The Church to-day is cursed by ineffectual formalism.

God speed the day when our Holy Bible will be understood thoroughly by all.

Can woman the noblest, fall the lowest?

Hell is a condition of mind.

God, Nature, Creative Influence, Spirit Force can be seen by the pure in heart. Without holiness no one can see the Lord.

All pastors and pulpits are as useless as ancient pottery.

Baptism from Heaven, by living in harmony with Nature,—the only genuine baptism.

The Holy Bible is so plain a fool can understand. Why don't others? God speed the day when ignorance shall be unknown in a Christian pulpit.

Ye are in harmony with Nature. All things will be seen. All spirit power needed will be at your disposal.

. . . do the works here spoken.

Money never cured a leprous body.

Home is what we make it.

Pastors are of no more value than old time vessels in modern houses.

Nature-God has found a faithful Christian child.

John the Baptist and others adopted a form that caused bad results.

Heaven and hell are confined within ourselves.

Were this my last breath, facing King Death, this grand thought I would leave to cheer us: Water Baptism in any form is a damnable curse, a stench in the nostrils of Jesus.

The pastor should experiment upon pottery instead of human brains. Shame!

Does my duplicate exist on the earth to-day?

Turning now to the peculiarities of the script in which these revealed sayings are all but concealed, the question arises, to what extent do the "picturesque" departures from normal standards have a meaning? This is, at once, the most interesting and difficult question. I am convinced that many of the fantastic variations of the letters, and the strange irregularities in their arrangement are whimsical rather than symbolic. The employment of dots, faces, extra lines, etc., is often dictated by purely æsthetic and spatial requirements. Although there is evidence that the writer used to make a rough, preliminary sketch of the page, it seems that he now works with a very incomplete visual image, allowing this image to develop as his pen rather aimlessly proceeds in the sinuous lines with which his writing abounds. That is, he indulges in these fantastic deviations from the beaten path, to produce that sense of passivity to a Guiding Power, which passiveness is at once the essence of his self deception, and for us the sign of a disordered inhibition. To the question, "Why did you make that *R* that way?" he answers, "The Creative Influence prevailed upon me to make it so." Often there is no more to be said.

We should, however, not be surprised to find a certain degree of symbolism. The paranoiac described by Noyes (*Am. Journal of Psychology*, Vols. I and II) had a veritable passion for symbolizing which he carried even to the decorations of his room. Sometimes this tendency is so marked as to lead alienists to use the term "symbolizing insanity." Similar to this is the tendency toward mysticism which McPherson says (Mental Affection, p. 217) may lead to the "formation of new words to express terms which are the products of the patient's diseased imagination." Chaddock also says (Outlines of Psychiatry, p. 167), "The speech and writing of the paranoiac often show striking peculiarities. Certain words are created that have a significance only for him; in his writing he employs

certain signs and symbols that have for him some mystic or delusional meaning."

To a considerable degree the case of J. D. exhibits this symbolizing tendency. Notice, as a first example, the double page shown in Figure 3 (see page 531 of this volume), which reads, *Watchman what of the night? Day dawneth.* Notice particularly the comparatively light aspect and "upward effect" of the right hand page, which are quite in harmony with the sentiment. The faces look upward; the three hands of the letter *t* all point upward, and, of course, the ladder (*H*) mounts upward. Pages which have a gloomier sentiment and speak of "a covenant with death" and "an agreement with hell," present a darker aspect; a mass of black serpents, for example, and the hands point downward.

Such a contrast is clearly shown in Figure 4. The left page reads, *Misery. Knowledge is Weakness. Evil.* The right page reads, *Happiness. Knowledge is Power. Good.* Compare the expressions on the faces of the letters *I* of the left *is* and the right *is*, and of the words *Misery* and *Happiness;* notice also the frail lines of the word *Weakness*, and the snaky appearance of *Misery* and *Evil.* This putting of opposites side by side is not uncommon.

Figure 5 reads, *Chosen* of *God-Nature for a Purpose. Be Firm. God-Nature-Reason-Jesus Christ-Heaven Everywhere. Yours Forever.* The central figure of the left page is the Lion of the Tribe of Judah, and is a very frequent symbol for Christ. (See Rev. 5:5.) The involved and interwoven manner of writing *God-Nature*, etc., is an attempt of the writer to give expression to his "identity philosophy," or his "philosophy and water;" that is, his idea of the Oneness of God, Nature, Love, Reason, Truth, Spirit Force, Creative Influence, Spirit Life, Unseen Power. He likes to combine all these in thought and writing into one unitary conception.

Figure 6 does not contain much symbolism. The dots may be vaguely interpreted as spirit eyes, and the faces as spirit forms. This specimen shows how intricate and baffling the writing may become. With sufficient shiftings of the base line, however, it may be made to read as follows: *Would you be a real man copy from Nature. Christ was a Naturalist Spirit Force. Accept Christ. Do his will and be a medium. 'Forgive them.'*

Figure 7 is an important document, being drawn up on Easter day. With the exception of a brief legend *Key to Heaven*, this specimen is truly ideographical. Beginning at the bottom (for the motif is "Up!") we have the three links of Fraternity, Love, Truth, symbolizing the Odd Fellow Lodge; next come the compass and square of Masonry, and then the crucifix,

bearing the face of Christ, which stands for Christianity. By these three stepping stones we mount upward until, *Eureka!* we are in Heaven. The close connection, in the drawing, between the three stepping stones is noteworthy.

Figure 10 represents the *Y. M. C. A.* and the *Church* (Protestant), the two institutions against which our subject has semi-persecutory ideas for reasons already given. They are so closely associated in his thought that he calls them the Twins. Figure 9 is the letter *I* taken from this word *Twins*, as it appears in one of the entries. Figure 14 represents the Twins when, after a period of grace he had granted them, they again rejected him. He takes his vengeance and vents his contempt in the expression he gives to their faces.

Figure 13 is the letter *I* in the word *Blind*, and needs no explanation. Figure 15 gives the word *Hell* with its environs. Notice the slender shaft on the left, pointing downward, and supporting a face in agony; notice also the tear-drops on the other faces. Figure 16 is the letter *O* as it appears in the word *who*, referring to a *simple pastor*. It is again an effort to put the appropriate expression (of simplicity) into the face.

Figure 8 is to be regarded as one of J. D.'s signatures, elaborate and full of symbolism. The basal design is a highly ornate boat; the boat with its occupants represents his whole life; it is going down stream to symbolize his declining years. The three occupants are the three life stages. The foremost with the infantile face represents J. D., as "a poor, ignorant child," to use his own self pitying language. The second is "youth nipped in the bud." The third is "the old man;" the lines above his eyes which suggest wrinkles, really are meant to indicate a "sag" in his head. Indeed, he has a slight depression in the top of his skull, which he claims to have received in childhood, and to which he attaches much importance; but the origin of which I have not been able to ascertain. It is hardly necessary to call attention to the fairly successful way in which he has differentiated the three life periods, and how he has indicated in the second the idea of "nipped in the bud." Fastened to the keel of the boat is the stem of the letter *N* which begins the word *Nature*. Smuggled into the boat, as it were, is the word *Impetus*. In the wake is the word *by*. Now putting all this together, and supplying from the context not given in the engraving, we have the following: *I—J. D.—whose life is symbolized by the boat and its three passengers, I who am at one with Nature, desire the Impetus that will come from an endorsement by* * * * *

Figure 17 reads, *Create Heaven by living in harmony with Nature's Laws.* The characteristic ladder *H* which begins the words *Heaven* and *Harmony* is this time connected at the bot-

tom with a symbol for Spirit Force, which Spirit Force must furnish the momentum by which we are enabled to mount the ladder to Heaven. In the lower right hand corner is the familiar *Lion of the Tribe of Judah*, and connected with the letter *t* in *Create* he is present again. At his side is a similar but novel figure, the *Lioness of the Tribe of Judah!* It takes these two principles, the male and the female, to *Create*, hence their close attachment to this word. "The lion is the fighter; she is more 'soggy' (sunken down)," was the explanation.

Finally, we have the richly wrought specimen reproduced in figure 18. With some patience the following can be deciphered: *Forsake Ignorance; Awake, Read. Water Baptism in any form* [is a] *Cloak*, [a] *Sham. Shame on the Tub.* The ground work design extending almost the whole length of the specimen is an armless, legless man, who looks as solemn and massive as an Egyptian god, but who is no other than a base, arrogant pastor ready to "douse" "the degraded persons waiting to be dipped." These latter are represented by a host of faces above the word *Tub*. At the bottom of the page is one prostrate face, and two others, to represent the degraded souls that have already been dipped. The pastor, it may be seen, wears "a priestly livery," and is covered with many parallel lines which represent his "rigid ignorance." On the back of his right hand (for, though armless, he has a pair of hands) is written *1900 years*, referring to the length of time during which the "accursed doctrine of water baptism" has been preached. His left hand bears the word *Wink*. Toward the lower right hand corner near the word *Tub* is "*the lion of the tribe of Judah*," winking at their ignorance. (See Acts 17:30.)

To the question "Why should these last specimens be so much more elaborate than the first?" the reply was, "More Creative Influence," which is at least a suggestion of an explanation, and does not belie the fact that there has been a genetic development. As far back as childhood, we find a schoolboy propensity to scribble and sketch. "He was a great hand for such things." In mature life, also, he was wont to carefully mark his gloves and other personal property with the insignia of his lodges and index fingers pointing to his name. These index hands are very prevalent in the picturesque writing. It is related how, when he at one time had occasion to label a bundle containing a sheepskin, he drew a sketch of a sheep and added *s-k-i-n* using this rebus device in preference to the ordinary printed word. It seems that he always took a certain pleasure in the grotesque; he enjoyed the comic pages of the Sunday newspapers and even copied some of their fantastic designs; he was fond of amusing himself and friends by

writing out "funny notes," in which curious shapes, caricatures with enormous heads and tiny feet might appear. Once he was repairing a stove, and on leaving his work he drew up an elaborate sign "Closed for Repairs," and added a series of pictures to illustrate a household event which happened that day. All these trivial things, occurring throughout his life and in his normal state, acquire a certain significance in the light of later developments, and point to a kind of incipient *cacoëthes scribendi*.

At the very outset of his present condition he showed his characteristic tendency to express his delusional ideas in motor terms. One of the first concrete things which the Creative Influence impelled him to do, was to stay up late into the night and arrange the seeds of the Thanksgiving pumpkin, upon a flat surface, so as to read, "*God is Love.*" Soon after this event came the umbrella incident, which resulted in the first case of symbolistic writing.

It was a faded, dilapidated umbrella and, to use his own account, "When I was walking by with it, a crowd of boys shouted 'Shoot the umbrella! Shoot the umbrella!' and threw snowballs at it. . . . Now I reasoned that the fault was not in the boys, but in the umbrella, and I concluded that I was carrying about an influence that was causing somebody to do harm." The event made a great impression upon him, and in a half serious, half playful mood, he made sketch after sketch of the old umbrella, which became the point of departure for a great amount of brooding and imaginative thinking. The outcome appears in the title page of the first volume of the picturesque writing. The portion of this title page which is reproduced in Figure 1, reads: *Past History, Present Duty. Shoot the Umbrella! Whatsoever thy Hand findeth to do, Do it with all thy might.* The umbrella in the upper right hand corner being the old one, represents *past history*, an antiquated doctrine, water baptism; the other new umbrella (differentiated by the modern parasol handle) stands for *present duty*, and the scriptural passage is in some way considered an injunction to do picturesque writing. In the most recent specimens the old umbrella still crops out as a symbolistic device, no doubt of exceptional importance. Figure 11 is part of a document which speaks of *Ancient History, Ancient Pottery* and a *Collapsed Patent.* The final *t* in the word *Patent* is shown, and it will be noticed that the idea of collapse is symbolized by turning a stripped umbrella, up side down. In Figure 12, again, there is a reference to *Past History* and *Water Baptism.* Notice the letter *i* in *Baptism* which is the old umbrella again.

It is now quite evident that we are dealing with a mind in which the associative processes, though not running riot, are

very volatile; and what is symbolism but associative thinking raised to a high power? J. D. is by no means a prosaic individual for whom A always suggests B. Indeed he has tried his hand at versification, and evinces a delight in figures of speech. Once he went out of his way to tell me that the same Force which bears the nightingale down will also bear him upward; and on another occasion he abruptly began to speak of a tree. "I think of myself as a tree. The trunk is my body, the branches, my head; the shoots are my thoughts." His wit is nimble. When asked "Why is your liniment necessary; why can't faith in God alone cure?" he promptly answered, "We need Science to assist Nature." When about to wrap up some books, instead of saying "I must put them into a bundle," he said, "I must make a consolidation." All this indicates a far removal from prosaic thinking. Recall in this connection his salient manner of differentiating the Lion and the Lioness of the Tribe of Judah. He delights in drawing contrasts, and making swift transitions in thought and emotional expression. "I am just as able in sarcasm as I am on the height of sublimity. I am the eagle on the top of the cliff and the Lion of Water Baptism below may growl, but I can scream, by the grace of Jesus, I can scream."

The pictorial tendencies of this manner of thought are carried into the picturesque writing, and although this writing is too consistently alphabetic to be called pictographical, it is often so symbolistic as to suggest analogies to the productions of the primitive mind. And since this is a case of senile involution, similarities to the workings of the child mind present themselves even more strongly. Consider, for example, the general character of a child's spontaneous drawing and the facile imagination which causes the child to anthropomorphize and endow with personality the otherwise stupid letters of the alphabet. There is no doubt but that when J. D. is in the act of writing, the page teems with pictorial imagery and scintillates with emotional values. Once he called my attention to a series of parallel lines which formed the foundation for the capital letter *D* in the word *Damnable*. "See those firm drawn lines," he said with some intensity; "they indicate rigidity of purpose, strength; they show my indomitable will." To the diseased mind, even the simple drawing of a line may have a symbolic meaning and an emotional content that is hard for us to understand, unless perhaps we get a hint from the *Einfühlung* (feeling in) theory of the æstheticians. According to this theory the psychology of symbolization cannot be explained by the ordinary laws of association, but we must consider it "an investiture of the object with the observer's own idea and feeling." As Lipps illustrates it, "I sympathize with the

[Doric] column's manner of holding itself and attribute to it qualities of life . . . " Now, if this is possible with the normal mind, on a normal emotional level, how much more possible is it for a disordered mind, which is hyper-responsive emotionally, and loves to run in allegorical channels. How natural for such a mind to animate its own art products and exhibit with great intensity this *Einfühlung*, this *Mitfühlung*, *Verschmelzung*, *Beseelung*. William Blake, the great symbolistic artist and illustrator of Dante's "Divine Comedy" and the "Book of Job," once wrote of himself, in a letter, as follows: "Excuse my enthusiasm, or rather madness, for I am really drunk with intellectual vision, whenever I take a pencil or graver in my hand." Such must be the general description of the state of mind which hovers over the picturesque writing.

The grotesque conformation of the script, the sepulchral odor of the books, and the realization that they were penned with long and patient labor in the deep hours of the night by a man who considered himself the inspired amanuensis of the Almighty, combine to give this strange manuscript a weird, almost uncanny character. If we but had a complete account of the conscious processes involved, the volumes of picturesque writing would constitute a most valuable psychological document.

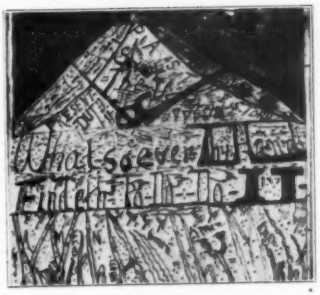

FIG. 1.

FIG. 2.

FIG. 3.

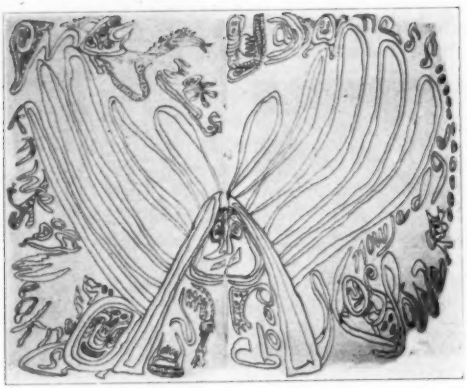

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

FIG. 9.

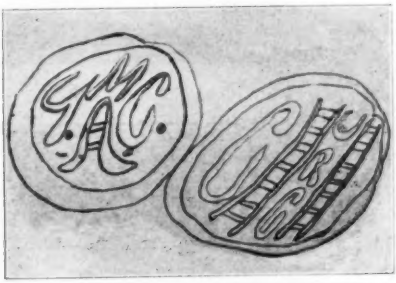

FIG. 10.

FIG. 11.

FIG. 12.

FIG. 13.

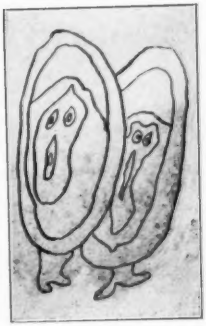

FIG. 14.

FIG. 15.

FIG. 16.

FIG. 17.

FIG. 18.

MINOR STUDIES FROM THE PSYCHOLOGICAL LABORATORY OF VASSAR COLLEGE.

COMMUNICATED BY M. F. WASHBURN.

I. SOME EXPERIMENTS ON THE ASSOCIATIVE POWER OF SMELLS.

BY ALICE HEYWOOD and HELEN A. VORTRIEDE.

The observation that smells possess a greater power to revive past experiences is so frequently made in every-day life, that it seemed worth while to attempt a laboratory test of its correctness. Of course, when a psychic phenomenon fails to manifest itself under the artificial conditions of laboratory experiment, it is not thereby proved to be an illusion in ordinary experience. But at least its non-occurrence under the fairly well known and simple circumstances of an experiment would indicate that the cause of its appearance out of the laboratory lies among the complexer conditions that are not reproduced by the method used.

The first series of experiments performed by us attempted to test the power of smell qualities to revive pictures which were presented to the observer at the same time with the smells. The method followed in general outline the Calkins method of studying associations. The observer was allowed to look at a picture laid before her on the table for five seconds, while inhaling an odor from a phial held to her nostril by the experimenter. After an interval of one minute another picture and another odor were given. When six pictures and six odors had been presented, the series of odors was given in a different order, and the observer described whatever imagery was suggested to her mind. The pictures were magazine illustrations about 6 x 8 inches in size, and were chosen as being about equal in vividness or exciting character. It was not, of course, possible to secure perfect equality of intensity in the odors, but the observer was instructed to report whenever an odor was disturbingly different in intensity from the rest.

The results of this series, as of all subsequent series, were treated in the following manner. Cases where the association between odor and picture might have been due to primacy, recency, or vividness were first ruled out. The percentage of

correct associations minus these cases was then calculated. In the next place the number of mistakes was reckoned when the association had, according to the observer's introspection, taken place by means of an ideational link, as for example, when the smell of rubber suggests the accompanying picture of a booted man through the medium of 'rubber boots.' These cases were set aside. There were left, besides the instances where no association or a wrong association was formed, two other classes: cases where the smell revived the picture for no reason whatever so far as the observer could discover by introspection, and cases where the link was affective in its character. Sometimes, for example, the observer would connect odor and picture because they were both disagreeable, or both pleasant. In this class, too, were reckoned the cases where the link was a sense of incongruity between smell and picture, as when a perfume accompanied a picture of a blacksmith's shop. The psychological nature of 'incongruity' is a matter of some dispute, but at least in such a case it is not an idea in the sense that 'rubber boots' is an idea.

Pictures were used in this first series of tests rather than simpler material because it is precisely the revival of such complex images that we have to deal with in ordinary life, where the superiority of smells as regards associative power is supposed to be manifest. In the later series, however, squares of differently colored paper were substituted for the pictures, in the hope of diminishing the number of associations through ideational links. Although the work with the pictures was thus left incomplete, inasmuch as no experiments were made testing the power of other material besides odors to recall them, the following table of results for the first series is subjoined. The observers, S. and B., were students of psychology with a fair amount of practice in introspection.

TABLE I.

Observer	I.	II.	III.	IV.	V.
S	42	66	16	30	54
B	48	77	37	2	61

Column I gives the number of experiments with each observer; column II, the percentage of correct associations less obvious cases of primacy, recency and vividness; column III the percentage of correct associations which had no discoverable link; column IV the percentage of correct associations that had affective links; and column V the percentage of correct cases

with ideational links. It may be worth noting that an attempt to substitute small squares of colored paper for the odors in the picture experiments was abandoned because the colors practically never failed to recall the pictures, as they were always mentally 'fitted into' the pictures by the observer, the color being assigned to some object so that picture and color formed a single perception.

Table II gives the results of experiments where smells were given along with squares of differently colored papers, about four inches to a side. These were manipulated as the pictures had been.

TABLE II.

Observer	I.	II.	III.	IV.	V.
S	42	69	33	14	52
B	36	58	33	8	59

The columns have the same significance as in Table I. It will be noticed that despite the greater complexity of the pictures as objects of perception and the consequent apparent probability that ideational links will be formed between them and the odors, the percentage of cases where such associations were actually formed, as shown in column V, is hardly noticeably less with the colors.

Table III, finally, shows the results of a series made with nonsense syllables, spoken by the experimenter, substituted for the smells, and associated with colors as in the series just described.

TABLE III.

Observer	I.	II.	III.	IV.	V.
S	42	88	45	12	43
B	54	79	51	14	35

The following conclusions are indicated on a comparison of the results, and by the introspection of the observers.

(1) The odors have no superiority in suggestive or associative power over the nonsense syllables.

(2) The cases where the link is affective rather than ideational have a special interest because it is sometimes suggested that smells derive their associative power from their power to reproduce affective states or moods. Observer S. showed a

decided tendency to associate odors with pictures by feeling links (see Column IV, Table I); on the other hand, she was quite as successful in associating odors with colors, where only 12% of the correct associations were made through affective connections. Observer B.'s tendency to associate by affective links was somewhat greater in the experiments with nonsense syllables (see Column IV, Table III) than in the smell experiments. On the other hand it may be urged that the cases of 'no link' possibly involved undetected affective connections; and we may note, also, that no account was taken of the instances where the link may have been both ideational and affective; only where it was purely affective was the case recorded.

(3) Links, ideational or affective, operate to assist recall not only in themselves, but through the fact that where they exist they give greater vividness and force to the impressions at first presentation. Probably a considerable portion of the effectiveness of incongruity, for example, as a link is due to the observer's paying more attention to the impressions because they are incongruous. It is further worth notice that while pleasantness and unpleasantness occasionally led to mistaken associations, *i. e.*, if there were two unpleasant colors in a series, an unpleasant smell might suggest the one with which it was not actually experienced, incongruity, where it operated at all, always brought about the right association.[1] Its 'relational' character seemed to connect it inseparably with both terms of the relation.

(4) Can any explanation be suggested for the fact that the commonly accepted superiority of smells in associative power does not appear under these conditions?

Smell sensations have in several respects a peculiar position among mental phenomena. They are, for one thing, more isolated than most other sensational elements. They come to us oftener detached from closely welded sensation complexes than do other kinds of sensation. Sound elements approach them in this respect; we have 'wandering sounds' as well as 'wandering odors,' but sound sensations are employed in intimate association with other elements in language. The closest fusion of smell sensations with other kinds occurs in those qualities which are associated with tastes, but these form only a small proportion of the total number of smell qualities. Now it may plausibly be supposed that when a sensation occurs in relative isolation, its associative power, its *central erregende*

[1] Associations are ascribed to affective links in these experiments simply on the introspective testimony of the observers that a common feeling tone was the cause of associating two processes. It is not intended to prejudice the question as to how far affective processes may properly be said to mediate association.

Wirksamkeit, to use Külpe's phrase, may be less restricted to one uniform set of accompanying elements than if it ordinarily occurs in a complex.

Further, any given smell quality is of comparatively rare occurrence in our mental life. This is due to two circumstances: the enormous number of qualitative differences in smells, and, still more, the fact that the organ of smell is so readily fatigued. The smells that constantly surround us disappear from our consciousness through fatigue; compared to the frequency with which we experience all the visual qualities and auditory qualities, we experience a distinct sensation of smell very rarely.

The result is that smell sensations as they occur in ordinary life are attended to in a greater degree, and more for their own sake, as it were, than any other sensation qualities. The smell of box recalls a garden frequented in childhood; no visual quality and no auditory quality is so infrequent and so detached an element of experience as the smell of box. The power of smells to revive associations is due largely to the conditions which favor attention to them in every-day life. Where, as under the circumstances of these laboratory experiments, the conditions are so arranged that attention does not favor smell sensations more than other material, such as nonsense syllables, the superiority of smells in associative power fails to appear.

PSYCHOLOGICAL LITERATURE.

A Treatise on Cosmology, by HERBERT NICHOLS. Vol. I. Introduction, 1904. University Press, Cambridge. Copies of this book can be purchased from the author. Address: 219 Commonwealth Avenue, Newton Centre, Mass. Price, $3.50 postpaid.

The present review of the above mentioned book is confessedly inadequate; but the importance of the work, and the fact that private publication will be likely to delay its general circulation, warrant some preliminary account of it. Although the book has been from the press more than a year but one review of it has been noticed, and that very brief and unsatisfactory.

Dr. Nichols here attempts, on the basis of a large consideration of the present data of physics and psychology, and in the light of the historical treatment of the foundations of the philosophy of science, to construct a complete hypothesis of the general principles of all the sciences, and finally to carry out these principles in a system of cosmology that will cover the main branches of human knowledge. The present volume contains the first principles, and a partial exploitation of them within the respective provinces of physics and psychology. At least the following sciences are to be treated in future volumes: (1) physics, (2) psychology, (3) sociology, (4) ethics (5) æsthetics, (6) religion. The order in which they will appear is not clearly indicated.

The introduction contains the following sections: (1) Scope and warrant of this treatise, (2) Historical review of cosmology in physics, (3) Historical review of cosmology within philosophy, (4) Partial summary to the present, (5) Quality, (6) Quantity, (7) Changeableness, (8) Lawfulness, (9) Presentativeness, (10) Personality, (11) Reflections on these six ultimate characteristics, (12) Recensed outlines for this treatise, (13) Recension of the elements and primary laws of physics, (14) Resultant reflections.

In a word, the chief standpoint of the work is to be "the result of developing the 'intellectual order' of Lotze, the 'symbolized order' of Professor Wundt, to clear, exact, and workable statements, such as may be actually applied in the practical business of all the sciences." It is, however, more than such a development, and in some of its main assumptions, it stands over against the philosophy of Wundt.

The main result of the historical treatment of cosmology within physics and philosophy is to show the kind of a cosmical theory that we may not now construct, in the light of historical momentum. The story of the unbroken course of physical theory in the direction of the elimination of substances and entities, is made to yield the conclusion that the world of physics has been reduced to mere space and

motion. "May not this same space and motion be reduced to some conception more reconcilable with what has been learned of the problem from the mental side?" Examination of philosophical theory in its historical process of elimination and clarification brings out the conclusion that the world of psychology is a world of non-spatial, but quantitative process or actuality. The neglect of quality by physics, and of quantity by psychology has led to a separation of these two worlds in a way that can no longer be maintained; science is now, but has never until this moment been, ripe for the final union of the mental and the physical sciences.

The universe is sensationally qualitative, quantitative, changing and lawful in ways symbolized by human experiences and conceptions, yet to be more fully determined and comprehended; a world of one kind of content, the absolute knowledge of which is forever impossible; but of which all possible knowledge is contained in such experience. What then are the universal characteristics of this content? These "cosmic traits" prove to be quality, quantity, changeableness, lawfulness, presentativeness, personality. A chapter is given to each of them with a view to orientating them within philosophy and bringing them to clear light and definition. It is with quality that in the future practical physics is most largely and intimately to deal. To the discovery by James and Ward of the quantitative character of all mental content, a large place is given. The exploitation of this, in its relation to the elements of physics, is the centre of the constructive work of the treatise. Changeableness is clarified by the elimination of traditional errors, and brought to mean that "concrete quality and quantity always are specifically inseparable. If one changes, the other changes also. Any change in either is absolutely change in both. When both change there is nothing in the specific content that is not absolutely changed." Just as causality must now be used only descriptively of lawful occurrence, lawfulness must only be used descriptively of similar occurrence, that is, descriptive of successive similar occurrences concretely and actually happening. Presentativeness concerns the unique and ultimate fact of togetherness of experience. This trait is exploited as fundamental to all psychology and cosmology. A presentation is all the momentary content of one field of consciousness. Personality is really another aspect of presentativeness, the rimming of certain qualities within one presentative field. A personality then is an actually existing and presentatively isolated state of mind. The human mind is such a continuously transforming personality. But as only one state of such a transforming personality actually exists at a time, therefore, from the point of view of cosmologic existence, our personality is but the one actually existing momentary state. A personality is a body of content presentatively joined within itself, and presentatively disjoined from all other content.

The six cosmic traits are pronounced ultimate and universal; no one can be conceived to be transformed into any other. They are then considered together, with reference to their development in philosophy up to the present time. They stand for a conception of philosophy that is purged of its entities and confusions, and simplified in the light of the principle of actuality; simplicity, clearness; concreteness characterizes them. Thus far the work is critical, and negative.

Now as to the more positive and constructive part of the work, which consists of an attempt by means of these six cosmic traits to develop a simple monistic scheme into which the laws and elements both of physics and psychology can be translated, and whose princi-

ples can be applied to all sciences. No adequate presentation is possible within the limits of this review.

Chapter XII contains the outline of the hypothesis of "physical points," which constitutes a figurative time and space scheme, or system of bookkeeping, in which the events of science can be kept account of and which shall represent adequately the actual happenings that are therein symbolized. The scheme rests upon the assumption that content is quantitative and that the sum of all quantities in the universe is forever constant. The distribution of this content into personalities, however, is constantly changing. The physical point, the unit of the time and space scheme, is an imaginary "personality." All are quantitatively equal, absolutely separate, and comprise each an endless series of one definite quality following or transforming into another.

Chapter XIII (about 100 pages) contains the recension of the elements and primary laws of physics into the time and space scheme. The three primary laws of physics are: (1) Every quality, when it changes to any other quality may be regarded as changing continuously through a theoretically conceived universal, fixed, and reversible order or Scale of Change towards or from the standard norm of that scale, and all qualities may be regarded as forever tending thus to change toward that norm.

Law II. When any change occurs in any given point change occurs in every other point in such a way that motion spreads from the given point uniformly and equally in every direction of a sphere having the given point for its centre. (Motion here as everywhere in the scheme means a certain non-spatial series of events.) Law III. All qualities are forever changing and their variable distribution in the Scale of Change and throughout the universe is such that while all changes conform to Law II the sum of their scale heights is constant. These statements will indicate to the physicist something of the nature of the recension to which his data are to be subjected. In terms of these laws the common formulas and notions of physics are then worked out.

In the concluding chapter, the usefulness, and fundamental importance of the theory is declared, and the shortcomings of present conceptions, especially the doctrine of parallelism, are set forth. Here the hypothesis is brought squarely against some of the basal conceptions of Prof. Wundt's philosophy. The chief point of contention can be explained by the following quotation "This system (Wundt's) assumes two absolutely disparate sorts of causality, one a mechanical sort that governs the ultimate realm of physics, or in other words the realm of the author's sensory content; the other a psychic sort that governs the realm of the author's feelings. The two sorts are assigned different realms of activity as fundamentally separate as the two worlds of Parallelism. Universal laws, therefore, are as impossible under this assumption as under the most naïve dualism.

It would be very difficult to appraise the value and the ultimate place of Dr. Nichols' hypothesis, and possibly less desirable for the moment than to look ahead to its more immediate effects. Whether or not it shall take a very high place among philosophic systems will depend of course much upon the future contributions to special science that the forthcoming volumes may be supposed to contain.

Among philosophic students of the idealistic persuasion, and the descendants of Kant in general, the effect of such a treatise is likely to be slight. It speaks a different language from theirs. Their common lack of scientific training and their preoccupation will probably prevent its leavening much their loaf. To those who believe that phi-

losophy may legitimately move on a lower plane and that its chief line of progress is to be in close relation to the development of inductive sciences, the book will come as a welcome help, possibly as a surprise. Such will agree, in the main, that the critical part of the work is sound and clear. In his constructive work the author is highly individual, and only a very long and severe testing of such an hypothesis from the standpoint of physics and psychology can enable one to decide its place. If it becomes widely known it must meet much criticism for it treats rather dogmatically some of the most central and burning problems of both sciences. The question of quantity in psychology is so new, and the notions of it so confused that the author's use of the concept as basal to his system may cast doubt upon its validity in some minds. It must be borne in mind, also, that any analysis of content that is psychologically final and complete may serve also as a basis upon which the terms of physics may be reconstructed; the fact that a quantitative psychology fits admirably the present needs of physics, is rather a proof of the general usefulness of the hypothesis than of its psychological validity.

It is doubtful whether in physics the hypothesis will gain much immediate recognition. The physicist finds his mass, length, and time so eminently usable, and he is as yet working so far from the foundations, that he may find the psychological approach to his field unattractive and too speculative and abstruse. It will be a long time before the ordinary physicist can learn to think in terms of quality. It cannot fail, however, to assure the physicist that there is a way of treating the problems of physics, that is more fundamental than the physical, and that psychology has a prior claim upon his notions. It ought forever to prevent such views about the nature of the universe as those of Reynolds being regarded as final.

The case within psychology ought to be different. The psychologist continually uses fundamental notions; and it is unfortunate but true that at the present time the fundamental notions of psychology are much befuddled; due in part, at least, to the philosophic ancestry of many of its problems and the inherited misuse of entities and complex notions. It is in such problems as those of sensational elements, analysis, synthetic unity and apperception that the work of Nichols ought to be most helpful. It points the way to a simpler, clearer, more thinkable psychology. The questions that he raises are of the most immediate importance, and whether or not one accepts his standpoint as a whole, the solutions that he offers make it imperative that his work be taken into account. The statement that the great problems of psychology are to determine what belongs to the mental state as such, and what to the brain processes outside of the field of consciousness: of those that belong to consciousness, what are presentative in nature, and what are conceptual,—brings psychology into a relation with physics and biology in a way that ought to enlighten some who are in the habit of regarding the conscious state as the beginning and end of the problems of psychology. The solutions that are suggested all along the line of psychological theory are consistent and clear. The notion of "togetherness" ought to go a long way towards reducing the confusion that has arisen or has been continued in psychology by dualistic conceptions, inadequate analysis, and misuse of doctrines of apperception and the like. The modern questions at issue between the voluntaristic and the intellectualistic psychology are brought to clear light. I repeat that the work of Dr. Nichols points the way to a clearer and simpler psychology. That is its most immediate service.

Taken altogether it is a notable book. It combines the best of German spiritualistic philosophy (with the transcendentalism left out) with the best of the English materialism, but in a manner entirely reconstructive. Considering it together with the biological movement in psychology it can fairly be maintained that it goes a long way toward laying the foundation for a distinctively American philosophy.

G. E. PARTRIDGE.

The Psychology of Beauty. By ETHEL D. PUFFER. Houghton, Mifflin & Co., Boston and New York. 1905.

The attempt has been made in this book to state and apply a comprehensive theory of æsthetic experience, which is based upon elementary psychological facts. The theory itself is outlined in the two chapters entitled 'The Nature of Beauty' and 'The Æsthetic Repose.' The remaining chapters of the book apply, expand and substantiate the theory. The theory itself may be best stated by the author. "Beauty is to bring unity and self-completeness into personality. . . . . The personality, as dealt with in psychology, is but the psychophysical organism; and we need to know only how to translate unity and self-completeness into psychological terms. The psychological organism is in a state of unity either when it is in a state of virtual congealment or emptiness, as in a trance or ectasy; or when it is in a state of repose, without tendency to change. Secondly, the organism is self-complete when it is at the highest possible point of tone, of functional efficiency, of enhanced life. Then a combination of favorable stimulation and repose would characterize the æsthetic feeling. But it may be said that stimulation and repose are contradictory concepts, and we must admit that the absolute repose of the hypnotic trance is not æsthetic, because empty of stimulus. The only æsthetic repose is that in which stimulation resulting in impulse to movement or action is checked or compensated for by its antagonistic impulse; inhibition of action, or action returning upon itself, combined with heightening of tone. But this is *tension, equilibrium* or *balance of forces*, which is seen to be a general condition of all æsthetic experience;" pp. 49f. Since the condition of this theory is muscular tension (for muscular tension, aside possibly from fluid or electrical tension, is the only tension of which one may properly speak in physiology), it is evident that the arts which appeal peculiarly to the eye and the ear are those alone which meet the requirement of the theory. It is, therefore the impression of the reviewer that while the theory fits in admirably with the beauty of Fine Art and fairly satisfactorily with the beauty of Music, the application of the theory to the Drama and to Literature is possible only by a vague and metaphorical use of terms.

H. C. STEVENS.

Ricerche di Psychologia: Volume primo. Laboratorio di Psicologia sperimentale, of the R. Instituto di Studi Superiori di Firenze, diretto da F. DE SARLO.

This first volume of Studies from the Florence Laboratory represents the achievement of the director and his pupils, during a little more than the first year of existence of the laboratory. While there is nothing original or even characteristic in the work, it reflects, in a general way, the present status of experimental psychology. The expressive method is the subject of two investigations; there is a quantitative study of the Müller-Lyer illusion, and a study of the perception of intervals of time. The two remaining researches are on dreams and thought transmission. There is also an account of an hallucination.

I. *Experimental Researches on the Perception of Intervals of Time.* Dr. Antonio Aliotta.

The instruments used in the study were the Meumann time sense apparatus and the Baltzar kymograph. The author's own experiments cover three points: (i) the effect on the apparent lengths of two equal time intervals of the time interposed between them: (ii) the determination of the indifference time: and (iii) subjective and objective rhythm. The method of right and wrong cases was employed in the first set of experiments. Two intervals of $\frac{1}{3}''$, separated by intervals that varied from $\frac{1}{3}''$ to $4''$, were presented to an observer. The second interval was increased or decreased by $\frac{1}{60}''$. The observer was required to state whether the second interval appeared equal to, greater than, or less than the first. There seem to be two results from the experiments. (i) Each observer has a time interval which is most correctly estimated. The precision of the estimate diminishes in the neighborhood of the extremes of the times used by the author. (ii) The conclusion drawn by Schumann, that the second interval is always underestimated in proportion to the time distance between the two intervals, is not entirely confirmed by Aliotta. The phenomenon does, however, occur in some observers. It is also pointed out that there is an illusory tendency subjectively to accentuate the limiting impressions of the second interval, in proportion as the time increases between the two intervals. But against the view that this accentuation accounts for the apparent shortening of the second interval, the author points out that these two phenomena, at least in certain observers, do not always appear conjoined. The experiments on the indifference time were carried out by the methods of right and wrong cases and of minimal changes. The lengths of intervals investigated varied from 12 to 140 sixtieths of a second. As a result of this part of his study, the author concludes that each observer has a slight tendency to a recurrent precision of judgment. The maxima of precision, however, are only relative. He also concludes, since the error of judgment does not bear a constant relation to the normal interval, that Weber's law does not hold. The results of the experiments on subjective and objective rhythm, in the main, confirm Meumann's results; although in the case of certain rhythmical forms, the subjective accentuation overcame the objective.

II. *Unconscious Movements in Various Forms of Psychic Activity.* F. de Sarlo and V. Berrettoni.

The apparatus used in this study was the Delabarre muscle recorder and the Sommer tri-dimensional analyzer. The authors observed the effects of attention to direction, feelings, recognition, intellectual work, and emotive states on the unconscious movements. The results of attention to direction were negative in all but one observer, who was cognizant of the purpose and theory of the experiments. There was no satisfactory result with feelings. In the reactions to recognition, two observers give results; and of these two, only one is self-consistent. The effect of mental arithmetic or reading is inhibition of movement. In emotive states there is no change in direction that is uniformly consistent with the quality of the emotion. On the whole, therefore, the experiments are negative.

III. *Geometrical Optical Illusions: Quantitative Research on the Müller-Lyer Illusion.* Vincenzo Berrettoni.

The chief problem with which this study is concerned, is to determine at what angle, formed by the two principal lines of the Müller-Lyer figures, the illusion is greatest. Fig. A (which makes obtuse angles with the principal line) was 10 mm long. Fig. B (which makes

acute angles with the principal line) had seven dimensions, namely, 9, 10, 11, 12, 13, 14, 15 mm. Fig. B, therefore, varied in length, in proportion to Fig. A, from $-\frac{1}{10}$ to $+\frac{5}{10}$ mm. A disc was made of Bristol board upon which Fig. A was mounted. The seven variations of Fig. B were mounted upon seven discs. These card-board discs were affixed to two metal discs, graduated in degrees and capable of rotation, which were borne upon a metal rod. It was thus possible, by mounting Fig. A upon the one metal disc and Fig. B upon the other, to vary the angular distance between them. Observations were made on meridians 5° apart. The observation consisted in comparing each one of the 7 figures of Fig. B with Fig. A, until a length was found which was judged equal to Fig. A. This comparison of the several Fig. B with Fig. A was made in both ascending and descending order of the lengths of Fig. B. The amount of the illusion in any angular position was thus measured by the particular Fig. B which was judged equal to Fig. A. The experiments were made upon 40 school children, whose ages varied from 9 to 15 years. There were three series of experiments, which are distinguished by the number of observers and by the dimensions of the figures used. I shall give only the results of the first series, the conditions of which have been stated, inasmuch as the results of the second and third series do not differ essentially from the first.

1. The value of the illusion varies with the order of experimentation; it is greater with the descending, less with the ascending manner of comparison.
2. The value of the illusion varies with the angular position. With the increasing order, the minimal value is at 40°; the maximal at 95°. With the decreasing order, the minimum is at 175°; the maximum at 90°. The mean value of the illusion has its maximum at 95°; its minimum at 115°.
3. The value of the illusion corresponds to about $\frac{1}{4}$ or $\frac{1}{5}$ of the length of the principal line.
4. The illusion is least in children of 9 and 10 years. It increases up to 13 years, and diminishes at 15 years.
5. Decrease in visual acuity increases the illusion.
6. The greater the skill in estimating small distances, the less the illusion.

IV. *Emotive Antagonism.* Sestilio Montanelli.

Graphic records were made of the radial and carotid pulse (from which the hæmic condition of the brain was inferred), the respiration, and the volume of the hand. Marey's instruments were used for the first three determinations; Hallion and Comte's plethysmograph for the last. The principal results are as follows:

Sensory Pleasantness:

1. Increased rate of pulse.
2. Increased rate of respiration.
3. Increased force of heart beat.
4. Passive perpheral vaso-constriction.
5. Variable vaso-dilatation of the brain.

Sensory Unpleasantness:

1. Increased rate of pulse.
2. Increased rate of respiration.
3. Increased force of heart beat.
4. Passive peripheral vaso-constriction.
5. Tendency toward cerebral vaso-dilatation.

Representational Pleasantness:
1. Active peripheral vaso-dilatation.
2. Variable changes in cerebral circulation.

Representational Unpleasantness:
1. Increased rate of pulse.
2. Increased force of heart beat.

Expectation:
1. Increased rate of heart.
2. Weak peripheral vaso-dilatation.
3. Cerebral vaso-dilatation.

Surprise:
1. Increased rate of heart beat.
2. Passive peripheral vaso-constriction.
3. Cerebral hyperæmia.

Fear:
1. Active peripheral vaso-constriction.
2. Increased rate of heart beat.
3. Cerebral vaso-dilatation.

Courage:
1. Peripheral vaso-constriction.
2. Increased rate of heart beat.

V. *Thought and Personality in Dreams: Contribution to the Scientific Study of Dreams.* Antonio Aliotta.

The author recorded his dreams for three months. His most noteworthy point, in his own opinion, is that the distinction between external perception and subjective reflection is present in dreams as in the waking state. He urges this fact against the theory that in dreams all images present themselves in the same vividness, because the control of actual perception is removed. This observation was confirmed by a questionary sent to 14 persons, to which there were 10 replies. The number of the author's own dreams was 115. Of these, the imagery of 115 was visual; of 55 motor; of 40 phonetic; of 40 auditory; of 15 tactual, of 7 olfactory; of 5 gustatory. The vividness of the visual images is greater in dreams than in the waking state, but there is not much difference in the vividness of the auditory images of words. Against Janet's theory that relates the dream to somnambulistic phenomena, the author argues that the ideational type does not change in the dream consciousness, while it does in the hypnotic consciousness.

VI. *Some Cases of Psychomotor Automatism.* V. Berrettoni.

This is a study of mind reading. Subject and experimenter sat in some experiments with hands clasped, and in others without contact. The eyes of the subject were sometimes blindfolded or shut, and sometimes open. The test did not consist merely in finding an object in one room, but it involved the searching for an object in more than one room or the conveyance of an object from one room to another. 120 tests were made on two observers. The results in 49 cases were correct; in 26 cases, partially correct; in 45 cases, wrong.

H. C. Stevens.

PSYCHIATRY.

By Isador H. Coriat, M. D.

RECENT LITERATURE ON PARAMNESIA.

Paramnesia, whether of the simple or reduplicative variety, has recently received a remarkable impetus, both in studies of the phenomena in normal individuals and its occurrences in various psychopathic states, psychasthenias and mental disorders. Recent text books, however, have given it but scant notice, but the current literature is rich in the reports of cases and the formulation of various theories. It bears a certain analogy to those peculiar losses of the feeling of reality, which are transient alterations in the feeling of recognition (or the so-called "sense of familiarity") or, on the other hand, to the feelings of "strangeness," the phenomena of the "never seen" as opposed to the sense of the "already seen" called by Janet, psycholeptic crises. The purpose of this brief review is to gather together and summarize the recent literature on the subject.

Outside of the strictly scientific contributions on the subject, the late Lafcadio Hearn, in a popular vein, describes the phenomena of paramnesia with a rare philosophic insight. (Kokoro, Hints and Echoes of Japanese Inner Life—Boston, 1896.) In discussing Shintoism and Buddhism, he raises the question whether the ego is the concentrated sum of the creative thinking of previous lives, and then adds—"To the same psychological category possibly belongs likewise a peculiar feeling which troubled men's minds long before the time of Cicero, and troubles them even more betimes in our own generation,—the feeling of having already seen a place really visited for the first time. Some strange air of familiarity about the streets of a foreign town, or the forms of a foreign landscape, comes to the mind with a sort of soft, weird shock and leaves one vainly ransacking memory for interpretations."

Grasset (La Sensation du 'Déja vu.' Journal de Psychologie normale et pathologique, Jan.-Feb., 1904), again essays to apply his geometrical polygonal scheme, to an explanation of these complex phenomena. He asserts that there are two equally essential elements:

1. The recognition of an image, of an emotion, of a psychic state, that one has the consciousness of never experiencing.

2. The ignorance of the origin of the first impression (visual or auditory image), and emotion previously acquired by the "psychisme." In the second case it is necessary that there be in the "psychisme" of the subject an image or an impression, which shares in it, which has been deposited or formed unknown to the subject. The patient shows a stupefying anxiety, when he ascertains the presence in his mind of an image or a precise impression, whereof he is unable to say when or how it came into his brain. Perhaps unconsciously or unknown to him, he acquires this psychic recognition, which he is able to later utilize in different conscious intellectual operations, without even recalling either the moment or the circumstances of the acquisition of this psychic recognition. The phenomenon is explained by double "psychisme" and the necessary separation of psychic centres, either superior or inferior (the polygonal schema); the superior being conscious, while the inferior is unconscious or subconscious. The two centres collaborate in an inextricable manner, but they are also able, in certain psychological or extra-physiological conditions, to disaggregate and functionate alone (disagrégation subpolygonale). In these states of subpolygonal disaggregation, the inferior psychic states are able to acquire diverse impressions, without the knowledge of the

superior psychic centres. The sensation of the "already seen" is not an illusion of false recollection of an impression whereof the subject ignores the first copy. In support of his theory, he quotes a letter from Paul Bourget who describes the characteristic "anguish" caused by the "already seen," but which became less as his mental powers matured. In the treatment of these conditions the patient must be taught to correct the impressions of the "already seen."

Léon-Kindberg has shown (Revue de Psychiatrie et de Psychologie Experimentale, Vol. VII, No. 4, April, 1903) that in cases of paramnesia the memory is very specific; the pose, expression, gestures, all being fully recognized as having taken place before. The phenomena may also occur only under conditions of fatigue, cerebral neurasthenia. The accompanying feeling is either curiosity, indifference, amusement or fear. Paramnesia may be an epileptic aura, and then is often associated with vertigo. In one tenth of the cases there is a feeling of depersonalization. After discussing in detail the various theories of paramnesia, the author undertakes to explain the phenomena on a rational basis. He concludes that the perception of reality requires a certain mental effort, an effort of synthesis, and, as this is absent in patients who are the subject of a paramnesic memory disorder, the environment is perceived with the same facility as a memory not requiring synthesis, and there arises the illusion that it is a memory, that the present has been perceived before.

G. Ballet (Un cas de "Fausse Reconnaissance" ou de "Déjà vu." Rev. Neurol., 1904, pp. 1221–1223) reports a case in whom the paramnesia followed an epileptic delirious state, the phenomenon being immediate and instantaneous, and of an auditory, visual, tactile and gustatory type. He believes that the disorder was produced by a transitory or permanent psychasthenic state, and is of the nature of an instantaneous dissociation.

Lemaitre (Des Phénomènes de Paramnesie à propos d'un cas special. Archives de Psychologie, Vol. III, pp. 101-110, Nov., 1903) gives the case of a young man of sixteen, with peculiar dreamy states, in whom things dreamt, seemed to come to reality a few days later. His explanation of the phenomenon is that the paramnesia consists of conscious revival of recent subcouscious perceptions, but which, by reason of their subliminal modality, appear to the consciousness as having occurred a long time previously.

Heymanns (Eine Enquête über Depersonalisation und "Fausse Reconnaissance" Zeit. f. Psychol. und Physiol. d. Sinnesorgane, Bd. 36, H. 5-6, 1904) carried out an investigation on forty-five students, of whom ten were women. The ages ranged between 20 and 25 years. Those in whom the paramnesia occurred were strongly emotional, changeable in morals, inapt and irregular in their work. The paramnesic had an inaptitude for mathematics, while the non-paramnesic showed an inaptitude for languages. In connection with this, it is of interest to note that Lemaitre's patient showed a taste for literature and the fine arts, but manifested a profound aversion for mathematics. The paramnesic is liable to the momentary experience that a familiar word is strange or meaningless. The most frequent time for the phenomenon to appear was in the evening when the subject is in a passive condition, tired, exhausted or engaged in uncongenial work.

Sidis (Multiple Personality, 1904) explains the phenomena of paramnesia on the principle of reverse movements, when subconscious experiences transmitted to central consciousness appear under the form of "familiar memories." He cites the well known example of the proof reader. Recently a new variety of the disorder known as "reduplicative paramnesia" has been described by Pick and Coriat

This is characterized in that a series of events in the patient's remembrance falls into manifold occurrences, the isolated events being impressed on the patient as repetitions thereof. It is distinct from multiple personality, in that the patient does not lose the sensation of his own ego. The published cases are reported very minutely, as the patients were all inmates of insane hospitals, so that an opportunity was presented to follow the disorder from day to day. So far, it has been found to occur only in various psychoses, general paralysis, delirium tremens, involution melancholia, dementia praecox, alcoholic deterioration, Korsakow's disease and senile dementia (presbyophenia). Normal individuals appear to be exempt. Characteristic of the disorder is a lengthening of the time sense, while the sense of familiarity is greatly intensified.

La Démence Précoce, par R. MASSELON. O. Joannin et Cie, Paris, 1904. pp. 199.

The interest in the deteriorating psychoses of puberty and adolescence is well shown by the multiplicity of publications on the subject. Masselon has given us a very readable and lucid exposition of the modern ideas of dementia praecox, and outside of Christian's classic monograph, published in 1899, we can recall nothing so complete on the subject. The book is divided into six chapters and deals with the history, symptomatology, prognosis, etiology and pathological anatomy of the disease. There are several illustrations showing katatonic and paranoic attitudes, and three plates illustrating the handwriting, with special reference to the stereotypy, poverty and scattering of thought. The author is the strongest however in the section devoted to the psychology of the disease, and here are seen the evolution and the summing up of his experimental work along this line, published in 1902 (La Psychologie des Déments Précoces). In summing up the psychical disorders of dementia praecox, we find the following striking traits:—emotional indifference, progressive diminution of voluntary and intellectual activity, lack of capacity of mental effort, progressive disappearance of complex memories with automatic preservation of simple memories, lack of precision and diminution in the number of mental images, fixation of certain ideas which are reproduced automatically. These symptoms were most marked in the katatonic form, appear early in the "neurasthenic" period of the disease, are accentuated, but finally narrow down in the acute period, but are still present in the terminal dementia.

Ten Lectures on the Biochemistry of Muscle and Nerve, by W. D. HALLIBURTON. P. Blakiston's Son & Co., Philadelphia, 1904. pp. 160.

This book comprises the Herter lectures given in New York in 1903, on the chemical physiology and pathology of muscle and nerve tissue. Like all of the author's publications, it is based on sound laboratory experiment and the conclusions are most convincing. The material throws much light on pathological anatomy and on the muscle contraction and nerve conduction theories of physiological psychology.

On the Methods of Later Psychiatry, by C. B. FARRAR. Am. Jour. of Insanity, Jan., 1905.

A comprehensive and readable summary of the recent advances in psychiatry, from the standpoint of pathological anatomy, physiological psychology and clinical psychiatry. Particularly well given is the summary of the work of Aschaffenburg on associations and of the chief criteria furnished by Kraepelin and his school on mental capacity and fatigue.

Paranoia, by R. PERCY SMITH. Jour. of Mental Science, Oct., 1904.

A comprehensive review and admirable criticism on the ever-perplexing "paranoia question," which will repay careful reading.

Autointoxication Psychosen, von E. MEYER. Archiv. f. Psychiatrie. Bd. 39. H. 1.

The anatomical changes strikingly resembled those observed by Bonhoeffer in delirium tremens (axonal reaction).

Bibliographie der Gesammten Wissenschaftlichen Literatur über den Alkohol und den Alkoholismus, von DR. MED. E. ABDERHALDEN. Urban und Schwarzenberg, Berlin, 1904. pp. 504.

A very comprehensive bibliography of everything pertaining to the alcohol question, from the chemical, physiological, pathological, psychological and sociological standpoint. It should be in the hands of every scientific worker.

Zur Pathogenese der Tay-Sachs'schen Amaurotischen Idiotie, von KARL SCHAFFER. Neurol. Centralblatt, May 1 and 16, 1905.

The author describes peculiar histological findings in an autopsy on a case of amaurotic family idiocy, a disease type which occurs almost exclusively in Jewish children and is characterized by idiocy, spastic paralysis and blindness, with an early lethal outcome. Sachs had previously described the degeneration of the cortical cells. In Schaffer's case there were noted peculiar ampulla-like and balloon shaped swellings on the basal dendrites of the large pyramids of the central convolutions. The glia cells were hypertrophied and the Betz cells were swollen with a disturbance of their fibrillar arrangement, while in the anterior horn cells, the fibrils had fallen to pieces and were gathered in fragments around the nucleus. The author looks upon the process as an "*Aufbrauch Krankheit*" in the sense of Edinger. The illustrations that accompany the paper show these peculiar swellings of the dendrites in an admirable manner.

Zur Auffassung Gewisser Symptome der Dementia Praecox, von E. STRANSKY. Neurol. Centralblatt, Dec., 1904.

One of the fundamental characteristics of dementia praecox, not pathognomonic of the disease, but occurring most frequently in it, is the loss of the inner unity of the understanding and the will. Especially marked seems to be the altered relation between the disturbances of the understanding and the corresponding affective states, so that there is a sort of a sejunction in the sense of Wernicke. The author gives in great detail a case which showed a peculiar confusion and disorientation, with random replies, peculiar aimless actions and finally a mild grade of deterioration. Even a summary of the case would exceed the limits imposed by a review. On account of the theft of which the patient was guilty, simulation was strongly suspected, but such thefts are a very prominent and early symptom in hebephrenia and general paralysis. Hysterical manifestations were shown by the random replies. Emotion was absent and the memory for the initial stage was hazy. From the very beginning the most prominent disturbance was in the inner unity, which immediately suggested a katatonic disease and spoke against amentia as well as simulation. The peculiar asymbolia and apraxia also pointed to katatonia. The case was a typical example of the loss of the inner unity of the mind, which the author calls intrapsychic inco-ordination or intrapsychic ataxia. The paper is an example of the minute clinical analysis of the German psychiatrists.

Sur une Forme d'Hypochondrie Aberrante due à la Perte de la Conscience du Corps, par G. DEMY et P. CAMUS. Rev. Neurol., May 15, 1905.

Recently the peculiar symptom of the loss of the feeling of reality and allied states has received a great deal of attention in psychiatry. Janet, in his last publication, has given us extensive clinical records and fine psychological analyses of these strange mental states, and August Hoch (Psychological Bulletin, Vol. II, No. 7, July 15, 1905) has reviewed all the recent literature on the question. The symptom occurs in various psychoses and psychasthenic states. Demy and Camus record a case which is in many respects remarkable, and in addition they give a critical review of the various theories which have been propounded to explain the condition. A woman, aged 47, suffered from periodic confused episodes following intense emotional states and in which these peculiar feelings of unreality arose. She would describe her feeling as follows: "I do not feel myself, I do not feel my limbs, I do not feel my head, I do not feel my hair. I have to continually touch myself to know who I am. It seems to me that my entire body is changed, sometimes it is as if I no longer existed. When I touch an object I have the sensation that it is not I who feels it." There was constant motor restlessness, she continually touched various parts of her body. She never complained of heat or cold. If the mouth was closed she could not locate her tongue. She claimed to have lost the senses of taste and smell, noises and the sounds of the human voice seemed different to her. "The world appears changed to me. Persons and things are like phantoms, as if they were not real. I am unable to imagine the figure of my parents or the interior of my house." The physical examination, excepting some vaso-motor disturbances, was negative, and there were no hysterical stigmata.

The external senses act only in an accessory and secondary manner in the conception of a personality. Wernicke and Storch have shown that all sensory perception is composed of two elements, the specific or sensorial element and the organic or myopsychic element. This latter is made up of the sensations of muscular activity, and their memorial images are intimately united to the images of organic sensations of internal or visceral origin. The totality contributes what is called the cenesthesia, the sense of our bodily existence, of our physical personality, the vague feeling we have of our being, independently of the existence of our senses. Foerster has given to the loss of this feeling the name of the afunction of the somatopsyche, or loss of consciousness of the body. Janet calls it the "dèlire cénesthésique," or obsession de cécité et de mort, or, what is still better, sentiment de dépersonnalisation. According to Janet, this feeling of reality is a function of the "mental level," which disappears when the psychological tension diminishes. In those patients who experience this sense of unreality, there exists a lowering or enfeeblement of the psycho. logical tension. The authors prefer the psycho-physiological theory of Storch and Foerster, to the purely psychological conception of Janet.

Einseitige Grosshirnatrophie mit gekreuzter Kleinhirnatrophie bei einem Fall von progressiver Paralyse mit Herderscheinungen, von TH. BUDER. Allg. Zeit. f. Psychiatrie, 1903, Bd. 60, H. 4.

In the course of general paralysis, presenting the classic symptoms, there followed a right hemiplegia after a series of apoplectiform attacks. The duration of the disease was 25 months. The autopsy showed an enormous atrophy of the left hemisphere (154 grammes less than the right) and also an atrophy of the right hemisphere of the cerebellum. Microscopically there were cell alterations in the central cortex and left frontal region, disappearance of the tangential fibres

and of a great number of the fibres of projection of the same side and a degeneration of the pyramidal tract continuing towards the internal capsule. The author discusses the question of the paralytic genetic processes in the brain. What is the cause of this great atrophy of the hemispheres? does it follow a process of another nature? is it the consequence of the paralytic process? or does the general paralysis develop in a brain where a hemisphere has been the seat of atrophy due to an arrest of development? By exclusion the author diagnoses an atypical general paralysis of Lissauer. Against the arrest of development, there is an equal development of the cerebral peduncles and of the pyramids. The real cause of this atrophy the author is unable to state.

[We have seen four similar cases of general paralysis with one-sided brain atrophy. In all these cases, focal symptoms were predominant, making a diagnosis from brain tumor very difficult at first, until the typical mental and physical decay cleared up the clinical side of the picture.]

Psychiatry, by STEWART PATON. J. B. Lippincott Co., 1905. pp. 618.

To the recent works on mental disorders, the result of the new impulse in psychiatry, especially in America, may be applied the oft-quoted "Of the making of many books there is no end." Dr. Paton's book, however, is the most serious effort on this important branch of medicine, made in the United States, and is thoroughly in keeping with the more modern lines of research, if we except a condensed abstract of Kraepelin published some two years ago. As a digest of the literature it is excellent, as an exposition of clinical psychiatry it has many faults, but these are considerably outweighed by the many admirable qualities of the book. True, it contains nothing new, and the author's experience in clinical psychiatry seems to have been rather limited, but it furnishes a good working basis for the student and general practitioner who wishes to become informed of the most recent lines in mental diseases. As an example of the great influence of the Heidelberg school, he follows in the main the classification of Kraepelin, but he has added in detail the researches of the French writers on hysteria, and the psychasthenias, and in view of the great importance of the latter group, not so much for the hospital physician, as for the general practitioner, the innovation is an excellent one. However, he groups the melancholias under the heading of senile psychoses, a classification obviously wrong, for clinical experience has shown how many of these states may appear during the pre-senile period. He recognizes the paranoic forms of manic-depressive insanity and also the atypical focal forms of general paralysis, although from the standpoint of symptomatology, he says nothing of the manic-depressive types of this latter disease. On page 85 it is stated that paramnesia is a mere distortion of memory, whereas it has been shown that this disorder is not one of a premeditated distortion, but is rather of profound dissociation, so strong that in the reduplicative forms it approaches a multiple personality. The stenographic production given of the flight of ideas, more nearly resembles the scattered thought of dementia praecox. Concerning the latter disease, the few lines on the relation of puberty, although fragmentary, yet are well taken and timely, as showing the modern tendency in this direction. He well holds out against charts for symptomatology as narrowing our conceptions and takes the firm stand for a thorough clinical study of each case independently, giving a short scheme for the mental and physical examination. The description of katatonic stupor lacks clearness, while the treatment of the paranoic states is too meagre. Outside of these few deficiencies, however, the book represents the most serious attempt at a clinical psychiatry, on a thoroughly scientific basis, that has yet been produced in America.

BOOK NOTES.

Nos Ancêtres Primitifs, par A. DOIGNEAR. Preface par Dr. Capitan. (Notes d'Archéologie Préhistorique.) C. Clavreuil, Paris, 1905. pp. 202.

With the assistance of his teachers, the professors at the School of Anthropology in Paris, this young member of the society has attempted the rather difficult task of compiling the results of recent studies of the industries and mentation of primitive man. He believes man's precursor existed in the eolithic, tertiary period, and discusses at length the remains found in the silex of Thenay, in the silexes of Otta and Poycourny, also the findings in other tertiary beds of southern France; discusses the Java man, or the pithecanthropus erectus of Dubois. He makes four ages of primitive humanity,—that of the cave bear, of the mammoth, of the elk, and of the aurochs. His palethnologic divisions are first neolithic, divided into Robenhausian of Mortillet, with polished stone poignards, gouges, arrow points, lances, monuments, pottery, with some agriculture and navigation; and secondly, the Campignian, studied by Salmon. These are the last quarternary stages, with our present fauna, climate, alluvium. Passing backward to the paleolithic age, we have first the Magdalenian, with work on bones, the mammoth and reindeer, with a cold, dry climate. Next older comes the Solutrean and the Menchecourian, with its transition industry, its flint arrow heads, its fluviomarine stratification, the appearance of the horse and the disappearance of the rhinoceros, and its moderate, dry climate. Earlier he places the Mousterian, with its cold, moist, glacial climate, with woolly animals. Next earlier come the Acheulean, with its clay formations; then the Chellean, with its rough instruments, its ancient elephants, and its warm, dry climate. Earliest of all in the tertiary, represented by the Puycournian remains, we have a yet more rudimentary industry, with the masterdon, hipparion, the dinotherium, and a warm, moist climate.

The construction is a very able one and is based essentially upon French explorations and theories.

The Bontoc Igorot, by ALBERT ERNEST JENKS. Department of the Interior Ethnological Survey Publications, Vol. I. Bureau of Public Printing, Manila, 1905. pp. 266.

This is a product of five months' study. Perhaps half the volume is made up of photographs, and, all things considered, it is one of the most interesting recent anthropological studies, comprising surveys of the culture groups, general social life, and family and tribal economic life and industries, political life, war and head hunting, æsthetic life and religion, with sample folk tales, and a brief final chapter on language. From this it is perfectly plain that this tribe has abundant legends and customs and beliefs of its own, and that the statements, so often made by early American educators who have visited the islands, that these are absent, are entirely unfounded. The basis of the Igorot religion is the belief in the ever present and watchful anitos, or spirits of the dead, that have great power for good or evil, and even life or death. All things have an invisible as well as a visible and material existence. With these the exorcist is in communication and it is through their power that he works. The forces of nature are personified, and these forms have merged into one supreme god,

Lumawig, over all and eternal, who had a part at the beginning, who came as a man to help and again later to teach, and who still lives to care. He dwells in the sky, is prayed to for harvests, for increase of crops and animals. At times he has exhibited marvellous power. He taught men their industries and ethics. There are sacred days, ceremonials galore, especially those connected with agriculture, sacred groves and rites.

The children have a variety of games. Puberty is rather late, usually between the fourteenth and sixteenth years, and has no rites except or because of the *olag*, which is primarily the sleeping place of all unmarried girls, and the mating place of young people. Here courtships occur and young men so inclined spend much time. Marriage almost always occurs after and, in a sense, because of pregnancy. There are also rather elaborate theories of disease and remedies. The burial ceremonies are highly developed and have many features that are unique. We cannot but welcome with great heartiness this first attempt of an American anthropologist to study the natives of our new possessions.

An Essay on Eastern Philosophy, by Y. MOTORA. R. Voigtlander, 1905. pp. 32.

This is a very interesting original attempt to compare and, to some extent, to fuse the fundamental views of the orient and of the occident. Modern psychology has helped to confirm certain oriental conclusions pertaining to the relations of the subject to the object, and of the subject and the product to consciousness of psychic potency and reality, the relations of reality and representation, the development of will and personality. The author began as a student of psychology at the Johns Hopkins University, but has gradually passed to philosophy where his dominant interest now lies.

Studies in the Psychology of Sex. Sexual Selection in Man, by HAVELOCK ELLIS. F. A. Davis Co., Philadelphia, 1905. pp. 270.

The author still calls his task "mainly of a tentative and preliminary character." Our knowledge is yet in the nebular stage. After a preliminary chapter on sexual selection as affected by external sensory stimuli, our author proceeds to discuss each sense with detail, and this constitutes this volume. He first deals with the primitive character of the skin; then with ticklishness; then with secondary sexual skin centres, the bath. He then passes to smell, discusses its primitiveness, the rise of olfaction, body odors of races, effective perfumes, the evil effects of excessive olfactory stimulation, the place of smell in sexual selection. Hearing begins with the physiological basis of rhythm, and passes to music, of which the author thinks the influence is small. Vision is the organ of beauty, but movement is involved as well. Two appendixes are given, one on the origin of the kiss, the other on the histories of sexual development.

Wunder und Wissenschaft. Eine Kritik und Erklärung der okkulten Phänomene, von RICHARD HENNIG. Ernst Schultze, Hamburg, 1904. pp. 247.

After an introduction he discusses the essence and meaning of suggestion in daily life and history, suggested conditions and acts, organic states, and its curative agency, suggested illusions and hallucinations, the belief in witches, suggested faith, suggestion in sleep and dream, etc. The second general section is entitled, "Okkultismus." The sub-sections are devoted to the wishing rod, reading and the transmission of thought, tipping tables, raps. He then discusses the sources of error in observation and memory, and thinks these are the chief support of superstition. He ascribes much importance to latent

memory and to unconscious reasoning, but inclines to believe in true *Ahnung* in the distance and in the future. The author is acquainted with American and English literature bearing on his subject, and has written a book that is sure to be of interest.

Metaphysical Phenomena. Methods and Observations, by J. MAXWELL. Preface by Charles Richet, and introduction by Sir Oliver Lodge. G. P. Putnam's Sons, New York, 1905. pp. 448.

Under method the writer discusses material conditions, the composition of the circle, the method of operation and personification. He next takes up raps, parakinesis and telekinesis and luminous phenomena. Under psycho-sensory and intellectual phenomena he discusses sensory automatism, crystal gazing, dreams, telepathy, telaesthesia, "A Complex Case," by Ritchet, motor automatism, automatic writing, phonic and mixed automatism and its psychology. In a final chapter he discusses fraud and error. L. I. Finch prints some recently observed psychical phenomena. The author's impressions are the result of ten years' psychic research. He has studiously refrained from giving a purely scientific aspect to his book, because it is unsuitable to the subject in hand. He does not expect to convince savants.

Psychologische Faktoren des modernen Zeitgeistes, von RICHARD BAERWALD. Die Bedeutung des Urteils für die Auffassung, von Paul Möller. (Schriften der Gesellschaft für psychologische Forschung. Heft 15. III. Sammlung.) Johann Ambrosius Barth, Leipzig, 1905. pp. 110.

The first article, by Baerwald, discusses the possibility of historical psychology, the predominance of rhythmic and pictorial types in the German classics, and the coloristic method generally. Other topics are the concrete and abstract type and the feeling for ideas, Goethe's time as abstract and the present as a concrete epoch, the alternation between these periods in human development, the psychology of mixed feelings, the hegemony of the latter in our day, the laws of the feelings for quietude, the departure of modern tragedy from what is naturally sad.

In the second article Möller very briefly discusses the views of other recent writers concerning the significance of the judgment for apprehension.

Psychological Medicine. A Manual on Mental Diseases for Practitioners and Students, by MAURICE CRAIG. P. Blakiston's Son & Co., Philadelphia, 1905. pp. 449.

After a brief discussion of normal psychology the author takes up the definition, cause, classification and symptoms of insanity, then discusses the states of excitement and depression, stupor, katatonia, paranoia, has a very brief chapter on dementia praecox, others on secondary and organic dementia. Under epochal insanities he classifies puerperal, climacteric and senile. Under intoxication psychosis he treats alcoholism, morphinism, opiumism, plumbism, and then come the general paralysis of the insane, the exhaustion psychoses, general neuroses, including epilepsy, hysteria and trauma. Obsessional insanity has a chapter by itself. One of the longest is that devoted to insanity and physical diseases, phthisis, diabetes, chorea, cretinism, malaria, etc. Under defective mental-development are included idiocy and moral insanity. Then come faint insanity, its relation to law, sleeplessness, care taking, and, last of all, treatment. The book is written by a practical physician who bases his conclusions chiefly upon his own experience, and troubles himself little about German theories, but has attempted some original work with the microscope on the brains of post mortem subjects.

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